EXHIBIT 4, ATTACHMENT A:

ESI, Acoustic Bat Surveys in the Hoosier National Forest (2020)

Pesi 1562.02

ACOUSTIC BAT SURVEYS IN THE HOUSTON SOUTH AREA OF HOOSIER NATIONAL FOREST IN MONROE, JACKSON, AND LAWRENCE COUNTIES, INDIANA

21 December 2020

Prepared for:

Mr. Jeff Stant, Executive Director
Indiana Forest Alliance
2123 N. Meridian Street
Indianapolis, IN 46202

Prepared by:

Environmental Solutions & Innovations, Inc.

4525 Este Avenue
Cincinnati, Ohio 45232
Phone: (513) 451-1777
Fax: (513) 451-3321
Ravenna, OH • Indianapolis, IN • Orlando, FL • Springfield, MO • Pittsburgh, PA • Teays Valley, WV

Executive Summary

Environmental Solutions & Innovations, Inc. (ESI) was retained by the Indiana Forest Alliance (IFA) to conduct acoustic monitoring of bats in an area of the Hoosier National Forest Called the Houston South Study Area (centerpoint 38.98776º, -86.23358º) in Jackson Lawrence, and Monroe counties, Indiana. Detailed, multi-year, bat diversity data may contribute significantly to IFA's overall goal of conserving old growth and mature forests throughout Indiana.

The current study was based on techniques outlined in the *Range-wide Indiana bat survey guidelines - March 2020* (USFWS 2020a). Acoustic detectors were deployed on 24 sites on 10 July and collected on 13 July 2020. Due to equipment malfunction, one site was resampled on 24 through 26 July 2020. All sites were sampled with Wildlife Acoustics Song Meter (SM) Mini Bat detectors with integrated SMM-U2 microphones or SM-4 detectors attached via a cable to an external SMM-U2 microphone. SM Mini detectors and the external microphones attached to SM-4 detectors were mounted to the top of 10-foot (3-m) poles, while SM-4 detectors were placed on the ground.

Acoustic data were analyzed using a two-step approach. First, all call files were downloaded and processed through Kaleidoscope Pro (Kpro) software (classifier v5.1.0 Wildlife Acoustics, Concord, Massachusetts). Second, a qualified biologist (Mr. Patrick Moore) visually examined all calls collected at each site and determined whether a species was present (e.g., confirmed), possibly present (potential), or absent.

A total of 39,191 files was recorded. Kpro identified 6,940 files as potentially containing bat call sequences and provided species-level identifications for 5,012 files. Visual review identified call sequences consistent with all eleven bats comprising year-round residents of Indiana. Call sequences consistent with big brown (*Eptesicus fuscus*), eastern red (*Lasiurus borealis)*, and hoary (*Lasiurus cinereus*) bats were identified at all 24 sites. Call sequences consistent with tricolored (*Perimyotis subflavus,* 22 sites), evening (*Nycticeius humeralis,* 21 sites), little brown (*Myotis lucifugus,* 10 sites), Indiana (*Myotis sodalis,* 6 sites), and gray (*Myotis grisescens*, 4 sites) bats were recorded at multiple sites. Calls sequences consistent with silver-haired (*Lasionycteris noctivagans,* 7 sites*)*, northern long-eared (*Myotis septentrionalis*, 2 sites), and eastern small-footed (*Myotis leibii*, 1 site), bats were recorded at one site each. If all eleven species are present, the Houston South Area represents an area of both regional and national importance for bat diversity and provides habitat for five species that are listed or under review for listing under the Endangered Species Act (ESA).

Future studies within the area should focus on verifying the presence of evening and eastern small-footed bats and on capturing and tracking eastern small-footed, gray, Indiana, northern long-eared, little brown, and tricolored bats to their roosts.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 Project Description

The Indiana Forest Alliance (IFA) seeks to inventory pollinators and bats in an approximately 37-square-mile (9582.96 ha) portion of the Hoosier National Forest (HNF) called the Houston South Area (centerpoint 38.98776º, -86.23358º) in Jackson, Lawrence, and Monroe counties, Indiana and encompassing portions of the areas designated by the HNF as Hickory, Fork, and Timber Ridge Areas (Figure 1).

Bats in Indiana face a variety of challenges including arrival of White-Nose Syndrome (WNS), a fatal fungal disease that has decimated populations of cave-hibernating bats, and expansion of wind energy facilities in the northern portion of the state, that kill migrating bats. Detailed, multi-year, bat diversity data can contribute significantly to IFA's overall goal of conserving old growth and mature forests throughout Indiana. IFA retained Environmental Solutions & Innovations, Inc. (ESI) to complete studies within the Houston South Area focused on bat species impacted by white-nose syndrome.

This report details methods and results of acoustic surveys completed on 10 through 12 and 24 through 26 July 2020.

2.0 Ecological Setting

2.1 Indiana Bat (*Myotis sodalis*)

2.1.1 Status

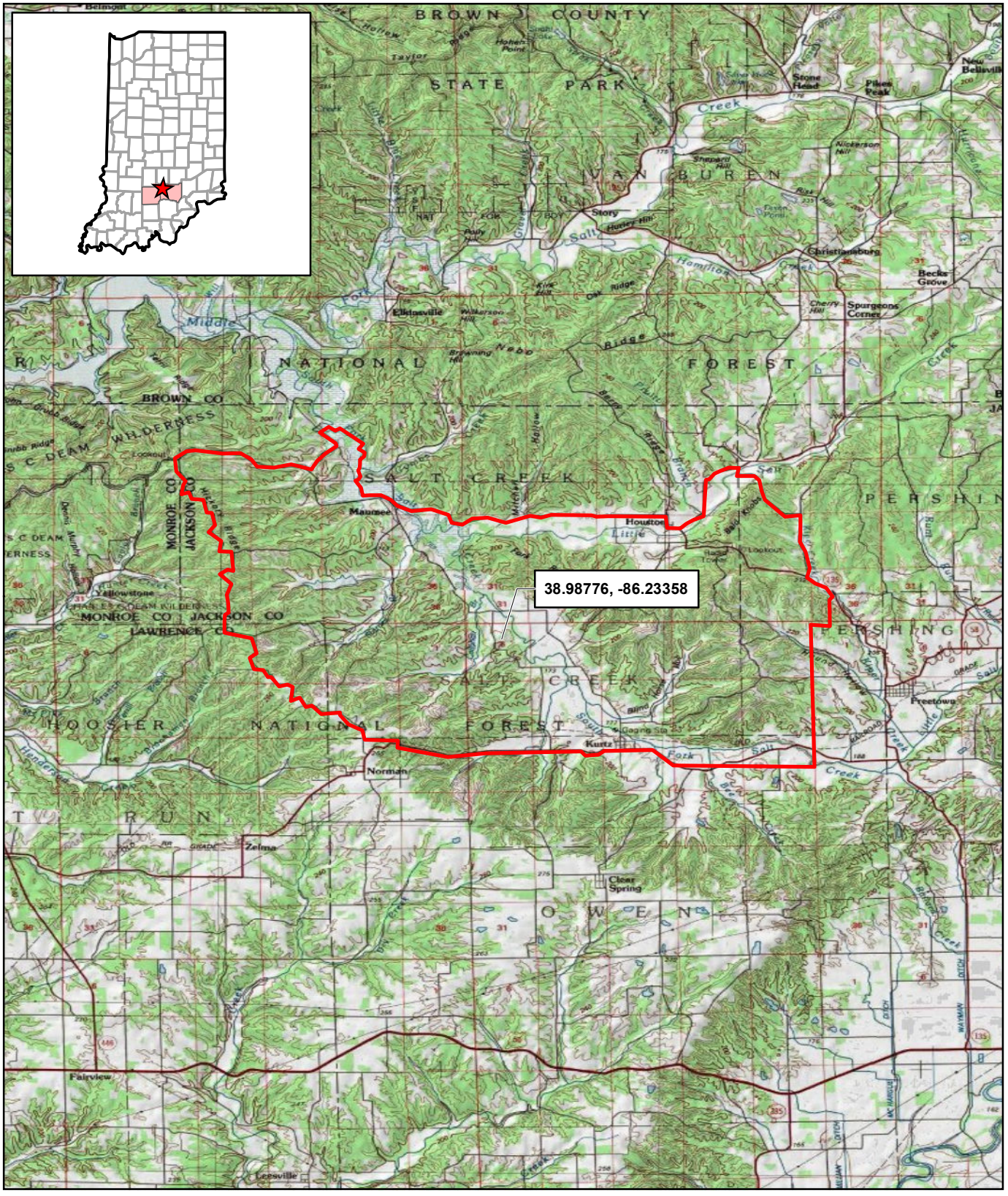
Federal Register Documents

32 FR 4001; 11 March 1967: Final Listing, Endangered

40 FR 58308 58312; 16 December 1975: Proposed Critical Habitat, Critical habitat- mammals

41 FR 41914; 24 September 1976: Final Critical Habitat, Critical habitat-mammals

The U.S. Fish and Wildlife Service (USFWS) listed the Indiana bat as endangered on 11 March 1967. The most current range-wide estimate of the population is 537,297 individuals, representing about 60 percent of the estimated population of 1960 (USFWS 2019). Long-term, detailed documentation of population changes are lacking across most of its range, with the exception of the state of Indiana (Brack et al. 1984b, Johnson et al. 2002, Whitaker et al. 2003), although such information is now being acquired in most states. It is probable that habitat loss during summer (USFWS 2007) and winter disturbances during hibernation (Johnson et al. 1998) both contributed to the overall decline of the species that lead to listing.



N
W E
S

Figure 1. Location of the Houston South Study Area in the Hoosier National Forest in Monroe, Jackson, and Lawrence counties, Indiana.

Project No. 1562	0 2 4 Miles Base Map: USGS Topographic Map	ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

G:\Current\1562_Houston_South_HNF\Maps\Bat_Survey\Report_Figures\Figure1_1562_Location_Topo_20200911.mxd; creator: thunter

With the arrival of WNS, this species has undergone significant population declines. Populations in the Appalachian and Northeastern Recovery Units have suffered the greatest declines. The Northeast Recovery Unit contained approximately 50,000 bats at the arrival of WNS, but contained approximately 13,500 bats in 2019, a 73% decline (USFWS 2019). The Appalachian Recovery Unit contained approximately 32,500 bats in 2011 but contained less than 2000 bats by 2019, a 94% decline. In Indiana and the rest of the Midwest population declines have been less substantial. The Indiana population contained 225,477 in 2011 and declined to 180,611 by 2017 before rebounding slightly to 184,848 bats in 2019, a decline of 18% from 2011. In Indiana, these count changes have also been associated with a shift of bat populations from the northern-most hibernacula in the state to more southern hibernacula.

2.1.2 Regional Species Occurrence

The Indiana bat is known to hibernate in 34 caves across Indiana (Whitaker et al. 2007). According to USFWS 2019 Indiana Bat (*Myotis sodalis*) Population Status Update, approximately 184,848 individuals winter within the state (34.4% of the species total population (USFWS 2019). In summer, the majority of maternity colonies are found in the northern part of the state; however, the species can be found throughout Indiana (Whitaker et al. 2007).

Despite recent declines, Indiana bats are known throughout Jackson and surrounding counties. Brack et al. (2004) provide a summary of studies of bats within the HNF during 1981 to 2003. Additional life history and ecology of the species is provided in Appendix A.

2.2 Gray Bat (*Myotis grisescens*)

Federal Register Documents
41 FR 17736 17740; 21 April 1975: List of Endangered and Threatened Fauna (10); 40 FR 17590 17591
41 FR 17736 17740; 28 April 1976: Determination that Two Species of Butterflies are Threatened Species and Two Species of Mammals are Endangered Species; 41 FR 17742 17747 (Shaus swallowtail; Bahama swallowtail; Mexican wolf, Canis lupus baileyi; gray bat, Myotis grisescens)
71 FR 16176 16177; 30 March 2006: 5-Year Review of Midwestern Species

2.2.1 Status

The USFWS listed the gray bat as endangered on 28 April 1976 in response to rapid declines associated with human disturbance in caves used by the species. At the time of listing, the gray bat population was believed to be approximately 128,000 individuals, but increases over the past few decades largely due to management activities brought the estimated total to potentially over 3,000,000 individuals during the most recent status review (USFS 2005).

Prior to the arrival of WNS, gray bat was being considered for delisting (USFS 2005). Gray bats get WNS, but no large-scale mortality events are known. In 2017, FWS developed a minimum population estimate of 4,486,263 gray bats (S. Marquardt, personal communication). All available metrics indicate gray bats are increasing in both

2.2.2 population and range.

This pattern is mirrored in Indiana where gray bats were not known to hibernate until 2009. In 2019 1,380 gray bats were counted in Indiana hibernacula (D. Brack, Personal Communication). Regional Species Occurrence
Gray bats in Indiana are primarily associated with an abandoned limestone mine in Clark County, but are now regularly found outside this stronghold (Whitaker et al. 2007). Historically, gray bats did not regularly hibernate in Indiana, but 1,380 gray bats were counted during the 2019 Indiana bat counts. Additional information on life history and ecology of the species is provided in Appendix A.

2.3 Northern Long-Eared Bat (*Myotis septentrionalis*)

2.3.1 Status

On 2 October 2013, the northern long-eared bat was proposed for listing by USFWS as endangered. On 16 January 2015, USFWS proposed listing the northern long-eared bat as threatened with a special rule under section 4(d) of the Endangered Species Act (ESA). On 2 April 2015, USFWS published notice in the Federal Register of its final decision to list the species as threatened and issued an interim 4(d) rule exempting certain activities from the ESA's take prohibition. The listing decision and interim 4(d) rule took effect 4 May 2015. A final 4(d) rule was announced on 14 January 2016 and took effect on 16 February 2016. On 27 April 2016, USFWS determined that designation of critical habitat was not prudent. Based on hibernacula studies, the northern long-eared bat suffered estimated losses of up to 99 percent in certain areas of the northeastern U.S. since 2005, leading to its status under the ESA as threatened (USFWS 2013). USFW is currently reviewing the species to determine if a change in federal status to endangered is warranted and expects to issue a final report on that decision by summer 2021 (USFWS 2020b). The species is considered endangered in Indiana (IDNR 2020).

Federal Register Documents

78 FR 61045 61080; 2 October 2013: Proposed Listing: Endangered
80 FR 2371 2378; 16 January 2015: Proposed Listing: Threatened; Proposed 4(d) Rule
80 FR 17973 18033; 2 April 2015: Final Rule: Threatened; Interim 4(d) Rule
81 FR 1900 1922; 14 January 2016: Final 4 (d) Rule
81 FR 24707 24714; 27 April 2016: Final Rule: Designation of Critical Habitat Not Prudent

2.3.2 Regional Species Occurrence

The northern long-eared bat is known to hibernate in 69 caves and mines in Indiana (USFWS 2016), most within the south-central region of Indiana (Whitaker et al. 2007). In summer, the species occurs throughout the state, with the majority in forested regions of southern Indiana (Whitaker et al. 2007). In January 2016, USFWS estimated that the northern long-eared bat population in Indiana consisted of approximately 127,842 individuals (USFWS 2016). Since WNS was documented in Indiana in early 2011, the number of northern long-eared bats detected decreased from 9 bats to 2 a 78 percent decline at the 11 major Indiana bat hibernacula (D. Brack, Personal Communication). Northern long-eared bats are difficult to detect in hibernation, but

summer captures have also greatly decreased indicating the species has suffered an extreme decline.

Prior to arrival of WNS, northern long-eared bats were the most frequently captured bat on the HNF (Brack et al. 2004) and both the Yellowwood and Morgan Monroe State Forests (Sheets et al. 2013). Captures of northern long-eared bats in this region are now greatly reduced. Additional information on life history and ecology of the species is provided in Appendix A.

2.4 Tricolored Bat (*Perimyotis subflavus*)

2.4.1 Status

The tricolored bat (*Perimyotis subflavus*) is not federally listed, but is a species of concern or listed at the state level throughout various states within the species' range. The species is considered endangered in Indiana (IDNR 2020). A petition to list tricolored bat as federally threatened or endangered was submitted to the USFWS 14 June 2016 (Center for Biological Diversity and Defenders of Wildlife 2016). On 20 December 2017, the USFWS indicated data provided were sufficient to initiate a formal status review (USFWS 2017). USFW is currently reviewing the species to determine if federal listing is warranted and expects to issue a final report on that decision by summer 2021 (USFWS 2020b).

Federal Register Documents

82 FR 60362 60366; 20 December 2017: Endangered and Threatened Wildlife and Plants; 90-day Findings for Five Species

2.4.2 Regional Species Occurrence

The tricolored bat ranges from the Yucatan Peninsula to Nova Scotia, New Brunswick (Broders et al. 2001), and Quebec, and east to the Atlantic Ocean. In recent years, the species expanded its range across the High Plains (Damm and Geluso 2008) and was subsequently captured in the Intermountain West including Texas and New Mexico (Sparks and Choate 2000, Geluso et al. 2005, White et al. 2006, Valdez et al. 2009). Rapid declines associated with WNS have negatively affected the hibernating populations throughout the species' range.

Prior to arrival of WNS, tricolored bats were frequently captured bat on the HNF (Brack et al. 2004) and both the Yellowwood and Morgan Monroe State Forests (Sheets et al. 2013). Since 2011, the population of tricolored bats has declined by 96 percent at eleven hibernacula in Indiana where Indiana bats are consistently counted (D. Brack, personal communication). Additional information on life history and ecology of the species is provided in Appendix A.

2.5 Little Brown Bat (*Myotis lucifugus*)

2.5.1 Status

The little brown bat (*Myotis lucifugus*) is not federally listed, but is a species of concern or listed at the state level throughout various states within the species' range. Little brown bat is considered endangered in Indiana (IDNR 2020). USFW is currently reviewing the species to determine if federal listing is warranted and expects to issue a final report on that decision by summer 2021 (USFWS 2020b).

2.5.2 Regional Species Occurrence

Little brown bats are widely distributed across North America from Alaska to Nova Scotia in the north, and from northern Florida to central Mexico east of the Sierra Madre Occidental in the south (Fenton and Barclay 1980). The largest colonies are in the northeastern and midwestern U.S., with the Northeast considered the core range of the species (Kunz and Reichard 2010). Distribution is limited by the availability of suitable caves and mines for hibernation, temperatures inside hibernacula, and the length of the season of hibernation (Humphries et al. 2002, Humphries et al. 2006). It is believed that a high density of caves in the Appalachian Mountain range and eastern Midwest (Culver et al. 1999) is responsible for larger populations of little brown bats in these regions (Kunz and Reichard 2010). Rapid declines associated with WNS negatively affected the hibernating populations of this species throughout its range.

Prior to arrival of WNS, little brown bats were frequently captured bat on the HNF (Brack et al. 2004) and both the Yellowwood and Morgan Monroe State Forests (Sheets et al. 2013). Since 2011, the population of little brown bats has declined by 89 percent at eleven hibernacula in Indiana where Indiana bats are consistently counted (D. Brack, personal communication). Additional information on life history and ecology of the species is provided in Appendix A.

3.0 Pre-survey Coordination

The current study was based on techniques outlined in the *R*ange-wide Indiana bat survey guidelines - March 2020 (USFWS 2020a). Guidelines were adjusted to account for 1) the large study area, 2) limited funds available to IFA, and 3) concerns about potentially infecting bats with COVID-19. In collaboration with the USFWS Bloomington Field Office and the IFA, ESI developed and obtained approval for the modified survey protocol aimed at maximizing probability of detection for the following species affected by WNS: little brown, tricolored, gray, Indiana, and northern long-eared bats. In lieu of mist netting, bat detectors were deployed at 24 widely-spaced sites to maximize target bat detection. The study plan also allowed detector retrieval after two nights of recording even if weather conditions were outside

USFWS guidance. While lack of detection on nights with weather conditions outside of USFWS guidance cannot be used to determine absence, detection on such nights can be used to determine presence. Final survey techniques were approved by USFWS on 8 June 2020.

4.0 Methods

Surveys are based on guidelines contained in the USFWS 2020 *Range-wide Indiana Bat Survey Guidelines* (USFWS 2020a) referenced as the 2020 Guidelines (Table 1).

Table 1. USFWS and ODNR Bat Acoustic Survey Guidelines.

2020 RANGEWIDE ACOUSTIC GUIDELINES

1. Survey dates: 15 May to 15 August in Indiana.
2. The number of acoustic sites required for a project:
    a. Linear Projects: 2 detector nights per 0.6-mile (1-km), or
    b. Non-linear Projects: 8 detector nights per 123-acres (0.5 square km).
3. Acoustic sites should be at least 656 feet (200 meters) apart.
4. A qualified biologist must identify detector sites, placing them in areas most suitable for detecting listed bats.
    a. forest-canopy openings
    b. near water sources
    c. wooded fence lines that are adjacent to large openings or connect two larger blocks of suitable habitat
    d. blocks of recently logged forest where some potential roost trees remain
    e. road and/or stream corridors with open tree canopies or canopy height of more than 33 feet (10 meters)
    f. woodland edges
5. The acoustic sampling period for each site must begin at sunset and end at sunrise (1 detector-night).
6. Use weatherproofing only when necessary.
7. Detector night is not valid when following weather conditions are observed during the first 5 hours of survey:
    a. Temperatures below 50º F (10º C),
    b. Sustained wind speeds greater than 9 miles/hour (4 meters/second; 3 on Beaufort scale), and
    c. Precipitation (rain and/or fog) that is intermittent or lasts in excess of 30 minutes.
8. Download and process calls using an approved acoustic analysis program. High-frequency (≥35 kHz) or myotid calls should be evaluated to either verify or reject the classification. At a minimum, for each detector site/night, all files from that site/night must be qualitatively reviewed if potential presence is suspected based on software analysis.
9. Acoustic files are saved and submitted to USFWS.

Sources: U.S. Fish and Wildlife Service; 2020

4.1 Level of Effort

As noted in section 3.0 above, financial constrains limited survey effort to 24 detectors sites. Detectors at each site are set to collect data for thee calendar nights resulting

in 72 nights of survey effort. High winds affected samples collected the nights of 11, 12, and 26 July. Sampling effort consisted of **25 complete and 47 partial nights** of effort, well below the level of effort required for a complete presence/absence survey (Table 1).

4.2 Type of Detector and Microphone

Sites were sampled with either a Wildlife Acoustics Song Meter (SM) Mini Bat detector (which contains an integrated SMM-U2 microphone) or a SM-4 detector attached via a cable to an external SMM-U2 microphone. SM-4 detectors were placed on the ground, with the microphone mounted to the top of 10-foot (3-m) poles. SM Mini detectors were mounted to the top of 10-foot (3-m) poles.

4.3 Site Selection

Preferred acoustic monitoring sites have limited clutter, which increase the quality of the calls recorded (Britzke 2004, Broders et al. 2004), and regular bat traffic, including: 1) borders of riparian corridors running through open landscapes; 2) fencerows adjacent open habitats; 3) utility corridors; 4) water sources including ponds and open stretches of streams; and 5) other open linear corridors, including logging and other woodland roads/trails. Detectors are placed at locations maximizing potential for detecting individual bats and providing access required to monitor detectors and ensure proper operation.

Typically, areas with high amounts of acoustic clutter created by wind, vegetation, insects, other bats, open water, sheer rock surfaces, or high-tension lines are avoided. In general, detectors are positioned at least 15 feet (5 m) in any direction from obstructions and in areas with minimal or no vegetation occurring (within 33 feet [10 m]) in front of the microphone. Detectors are placed parallel to woodland edges and at least 49 feet (15 m) from known or suitable roosts. Microphones are elevated a minimum of 10 feet (3 m) above ground level. Where possible, detectors are placed a minimum of 656 feet (200 m) apart.

For the current study, acoustic sites were pre-selected by Dr. Dale W. Sparks based on available aerial photography with input on current field conditions provided by Dr. Robert Jean, leading concurrent bee studies. Final detector positions and microphone orientation were selected by biologists in the field operating under supervision of a permitted bat biologist, Mr. Michael Mairose.

Acoustic site coordinates are provided in Table 2 and detector site locations are provided in Figure 2. Detector deployment datasheets are provided in Appendix B and photographs are provided in Appendix C.

Table 2. Acoustic detector site coordinates for the Houston South Study Area in the Hoosier National Forest in Monroe, Jackson, and Lawrence counties, Indiana.

Acoustic Monitoring Site	Date (2020)	Latitude	Longitude
1562-AS-001	10, 11*, 12* July	39.0189527198794	-86.3041238909486
1562-AS-002	10, 11*, 12* July	38.9960590142014	-86.3005106045679
1562-AS-003	10, 11*, 12* July	38.9893515636672	-86.3030923141854
1562-AS-005	10, 11*, 12* July	38.9730906294954	-86.2887492015048
1562-AS-008	24, 25, 26* July	38.9963413583157	-86.2633472572464
1562-AS-09	10, 11*, 12* July	39.0010685838244	-86.2594184924193
1562-AS-010	10, 11*, 12* July	39.0129558655466	-86.2647777776239
1562-AS-011	10, 11*, 12* July	39.0130518117703	-86.2626355067754
1562-AS-012	10, 11*, 12* July	38.9730977544446	-86.2633446593186
1562-AS-013	10, 11*, 12* July	38.9976279551249	-86.2078491045332
1562-AS-014	10, 11*, 12* July	39.0123550860872	-86.2043360054594
1562-AS-015	10, 11*, 12* July	39.0124157213362	-86.2073153767954
1562-AS-016	10, 11*, 12* July	39.0178893540884	-86.2066697656855
1562-AS-018	10, 11*, 12* July	39.0173241534294	-86.2327310994135
1562-AS-020	10, 11*, 12* July	39.0111864824484	-86.2474733973553
1562-AS-021	10, 11*, 12* July	39.0090553012398	-86.2530810308034
1562-AS-022	10, 11*, 12* July	39.0091808423166	-86.2448806366631
1562-AS-023	10, 11*, 12* July	39.0079507653971	-86.2555124774267
1562-AS-027	10, 11*, 12* July	39.0028268787856	-86.1897920555324
1562-AS-028	10, 11*, 12* July	39.0033632099623	-86.1979559062069
1562-AS-029	10, 11*, 12* July	39.0009731498166	-86.206374635877
1562-AS-030	10, 11*, 12* July	39.0051675206037	-86.2057663075464
1562-AS-031	10, 11*, 12* July	39.0226049357373	-86.2821920955137
1562-AS-032	10, 11*, 12* July	39.0213969208685	-86.2896699360434

*Partial night due to bad weather (rain and/or high wind).

4.4 Automated Data Analysis

All call files are downloaded and processed through Kaleidoscope Pro (Kpro) software (classifier v5.1.0 Wildlife Acoustics, Concord, Massachusetts). The software extracts parameters including the frequency, time, and slope components of each pulse. Each pulse is then assigned a species-level identification, with the entire sequence assigned based on the species most frequently identified. In some cases, even very low confidence identifications are of value including instances where biologists attempt to locate a rare species such as the Indiana bat. In other cases, such as academic research or studies aimed at regulatory compliance, a more complete level of identification is required. The software allows users the option of tightening or loosening the stringency of the rule governing species-level identifications and can also be adjusted to restrict the analysis to only those species expected to be present (to avoid misidentifications).

The software makes use of maximum likelihood estimators (MLE), a multivariate statistical technique used to test the strength of a proposed relationship based on known or assumed error rates. In this case, the proposed relationship is the presence of protected bats identified by analytical software. The MLE accounts for the number of call sequences identified as a species and compares that to the number of call sequences identified as belonging to a similar species based on assumed error rates.

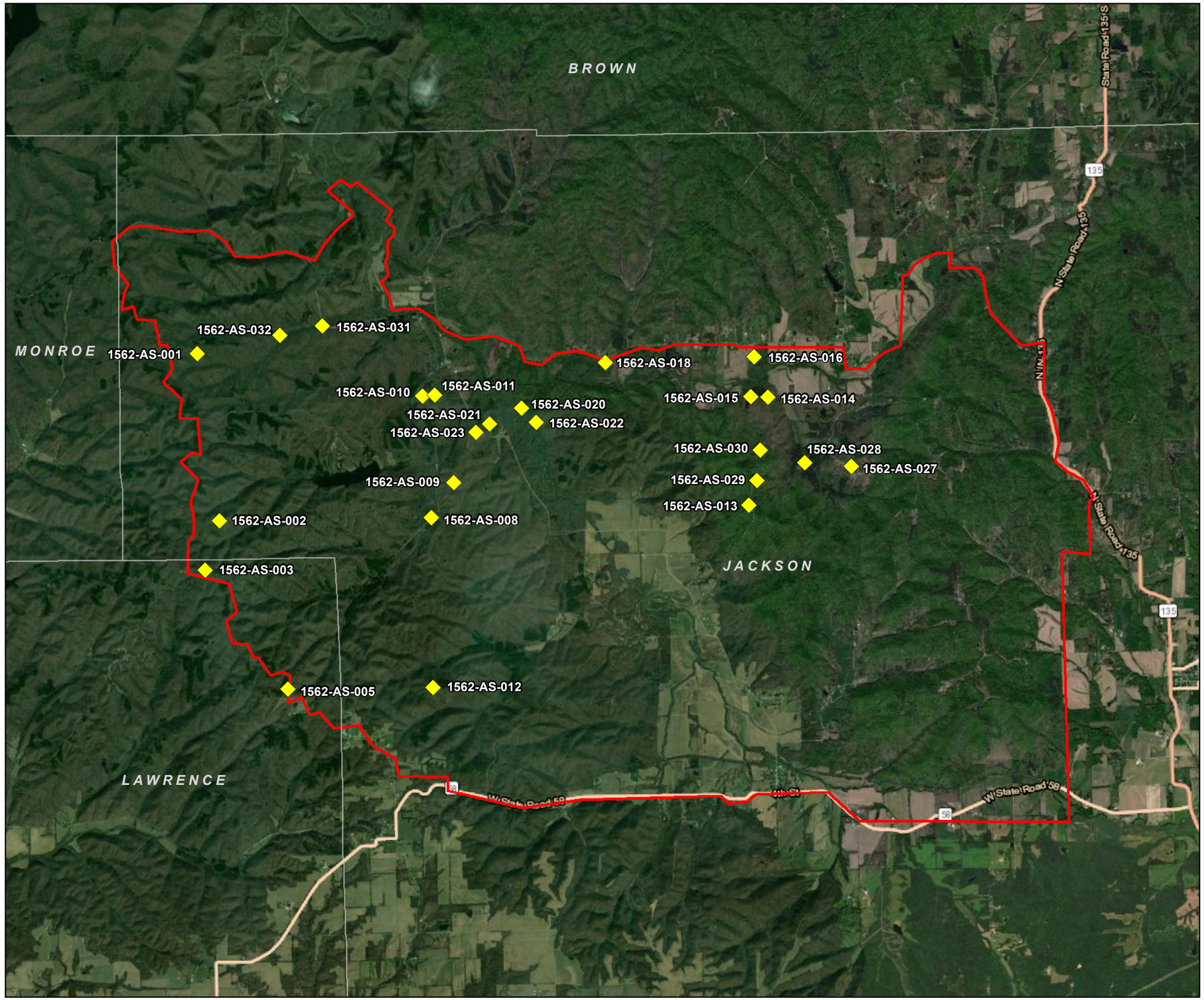


Figure 2. Acoustic detector locations in the Houston South Study Area on the Hoosier National Forest in Monroe, Jackson, and Lawrence counties, Indiana.

- Acoustic Detector Location
- Houston South Study Area
- County Boundary

N
W E
S

0 0.75 1.5 Miles

Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Project No. 1562

G:\Current\1562_Houston_South_HNF\Maps\Bat_Survey\Report_Figures\Figure2_1562_Detector_Locations_20200910.mxd; creator: thunter

Assumed error rates are obtained by testing the software packages against libraries of known calls. The goal is to provide a mechanism to eliminate errors resulting from misclassification. Eleven species with potential presence in the immediate and surrounding areas of the Project are included: big brown (*Eptesicus fuscus),* eastern red (*Lasiurus borealis),* hoary (*Lasiurus cinereus),* silver-haired (*Lasionycteris noctivagans*), eastern small-footed (*Myotis leibii*), little brown, northern long-eared, Indiana, gray, evening, and tricolored bats. The zero (balanced/neutral) sensitivity setting is used for analysis and classifier package, allowing calls to be classified to the species-level based on the greatest percentage of the call classified as a single species. Acoustic data are provided electronically upon request and are stored for five years.

4.5 Visual Data Analysis

All files recorded on nights with a significant MLE for a listed species are visually examined by an expert bat acoustic identification specialist (Mr. Patrick Moore; resume provided in Appendix D). Qualitative vetting includes identification to species by focusing on morphological call characteristics such as frequency, slope, duration, and intensity.

4.6 Habitat Assessment

Concurrent with detector deployment, the Project is assessed for suitability for use by Indiana and northern long-eared bats. The emphasis of this description is habitat form: size and relative abundance of large trees and snags that potentially serve as roost trees, canopy closure, understory, clutter/openness, distance to water, and flight corridors.

ESI's habitat characterization does more than emphasize species of large trees. It identifies components of the canopy and subcanopy layers. All trees that reach into the canopy are canopy trees, regardless of their diameter/size. Many smaller trees are often also found in the canopy, and in some situations, the canopy can be entirely composed of smaller diameter trees. ESI's habitat characterization identifies dominant and subdominant elements of the canopy.

The subcanopy, or understory, vegetation layer is well defined in classical ecological literature. It is that portion of the forest structure between the ground vegetation (to less than 3.2 feet [1 m]) and the canopy layers, usually beginning at about 25 feet (7.6 m). Vegetation in the understory may come from:

- Lower branches of overstory trees;
- Small trees that will grow into the overstory;
- Small trees and shrubs that are confined to the understory.

Habitat assessment datasheets are provided in Appendix B.

4.7 Weather and Temperature

To ensure compliance with USFWS guidelines, weather is monitored during the acoustic survey. For this study, all data were analyzed regardless of weather conditions. A table summarizing weather conditions during the survey is provided in Appendix E.

5.0 Results

Twenty-four Wildlife Acoustics bat detectors were deployed at 24 sites. Detectors were deployed at all sites the night of 10 July 2020 and retrieved on 14 July. The detector at site 1562-AS-008 did not record data due to a malfunction. Thus, a single detector was placed at site 1562-AS-008 the night of 24 July 2020 and retrieved on 27 July. A total of **72 detector nights** of data was collected, including 25 nights in compliance with USFWS weather conditions for presence/probable absence surveys.

Acoustic detectors were programmed to begin recording 30 minutes before sunset and cease recording 30 minutes after sunrise. Examination of recording logs, with the exception of first round studies at site 1562-AS-008, indicated detectors operated as programmed.

5.1 Analysis of Call Sequences

Data files recorded totaled 39,191. Kpro identified 6,940 recordings potentially containing bat call sequences including 5,012 files identified to species-level (Table 3). Call sequences consistent with all 11 species used in software analysis were identified. A single call sequence consistent with eastern small-footed and two call sequences consistent with northern long-eared bat were identified.

Table 3. Bat calls identified by Kaleidoscope Pro with automated call identification on Houston South Study Area in the Hoosier National Forest in Monroe, Jackson, and Lawrence counties, Indiana.

Site	Date (2020)	EPFU	LABO	LACI	LANO	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	Total/ Site
1562-AS-001	10 July	197	37	28	11	4	0	5	0	3	6	63	**354**
	11 July*	262	2	1	0	0	1	3	0	1	1	0	**271**
	12 July*	82	59	8	1	3	0	5	1	2	2	15	**178**
1562-AS-002	10 July	5	6	8	1	0	0	0	0	0	9	0	**29**
	11 July*	1	1	2	0	0	0	0	0	0	0	0	**4**
	12 July*	0	2	3	1	1	0	0	0	1	8	0	**16**
1562-AS-003	10 July	3	9	4	1	1	0	1	0	0	14	3	**36**
	11 July*	2	2	2	0	0	0	1	0	0	0	0	**7**
	12 July*	5	7	3	0	1	0	1	0	0	10	0	**27**
1562-AS-005	10 July	13	12	13	0	0	0	2	0	0	5	0	**45**
	11 July*	3	0	2	0	0	0	0	0	0	0	0	**5**
	12 July*	9	5	14	1	0	0	1	0	0	9	0	**39**

Site	Date (2020)	EPFU	LABO	LACI	LANO	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	Total/ Site
1562-AS-008	24 July	2	8	4	0	0	0	0	0	0	1	1	**16**
	25 July	1	1	0	0	0	0	0	0	0	0	0	**2**
	26 July*	2	3	0	0	0	0	1	0	0	2	0	**8**
1562-AS-09	10 July	4	4	4	0	0	0	0	0	0	5	1	**18**
	11 July*	2	2	2	0	1	0	0	0	0	2	1	**10**
	12 July*	10	9	7	2	1	0	3	0	1	24	6	**63**
1562-AS-010	10 July	7	12	8	1	1	0	3	0	0	6	2	**40**
	11 July*	3	3	1	0	0	0	0	0	0	1	1	**9**
	12 July*	7	13	0	0	2	0	1	0	0	0	4	**27**
1562-AS-011	10 July	10	15	5	1	0	0	2	0	0	5	1	**39**
	11 July*	4	4	3	0	0	0	0	0	0	5	1	**17**
	12 July*	5	8	0	0	1	0	1	0	0	5	1	**21**
1562-AS-012	10 July	4	7	5	0	0	0	3	0	1	7	0	**27**
	11 July*	0	0	1	0	0	0	0	0	0	0	0	**1**
	12 July*	0	6	1	0	0	0	4	0	0	9	0	**20**
1562-AS-013	10 July	63	33	22	5	2	0	6	0	0	18	4	**153**
	11 July*	8	0	22	0	0	0	0	0	0	0	0	**30**
	12 July*	125	51	23	9	2	0	6	0	0	136	2	**354**
1562-AS-014	10 July	1	20	4	2	11	0	4	0	1	2	4	**49**
	11 July*	3	0	0	0	0	0	0	0	0	0	0	**3**
	12 July*	4	4	0	0	0	0	0	0	0	2	0	**10**
1562-AS-015	10 July	43	146	17	1	20	0	12	0	0	10	6	**255**
	11 July*	92	3	2	0	0	0	0	0	0	0	0	**97**
	12 July*	38	155	5	0	4	0	3	0	0	5	6	**216**
1562-AS-016	10 July	26	27	52	5	0	0	10	0	0	9	1	**130**
	11 July*	23	0	1	2	0	0	0	0	0	0	0	**26**
	12 July*	115	27	31	4	3	0	2	0	1	15	2	**200**
1562-AS-018	10 July	2	4	8	0	1	0	0	0	0	2	1	**18**
	11 July*	0	0	0	0	0	0	0	0	0	0	0	**0**
	12 July*	1	1	2	0	0	0	0	0	0	1	2	**7**
1562-AS-020	10 July	16	13	53	5	22	0	3	0	0	1	44	**157**
	11 July*	5	0	4	0	0	0	0	0	0	0	0	**9**
	12 July*	37	2	43	0	13	0	0	0	0	0	43	**138**
1562-AS-021	10 July	10	47	3	1	3	0	10	0	0	13	0	**87**
	11 July*	15	134	4	1	5	0	32	0	0	8	0	**199**
	12 July*	11	49	2	0	5	0	10	0	1	7	1	**86**
1562-AS-022	10 July	29	92	48	5	6	0	22	0	4	19	21	**246**
	11 July*	3	5	1	1	0	0	2	0	0	1	0	**13**
	12 July*	13	75	13	4	11	0	13	0	1	11	5	**146**
1562-AS-023	10 July	6	6	15	2	0	0	0	0	1	1	3	**34**
	11 July*	0	3	3	1	0	0	0	0	0	2	0	**9**
	12 July*	1	22	1	0	0	0	1	0	0	1	2	**28**
1562-AS-027	10 July	66	97	25	1	0	0	3	1	0	8	2	**203**
	11 July*	33	0	2	1	0	0	0	0	0	0	0	**36**
	12 July*	24	115	15	1	1	0	3	0	0	15	1	**175**
1562-AS-028	10 July	37	8	21	0	0	0	1	0	0	4	0	**71**
	11 July*	11	0	0	0	0	0	0	0	0	0	0	**11**
	12 July*	20	7	8	0	0	0	2	0	1	1	0	**39**
1562-AS-029	10 July	8	49	4	0	0	0	1	0	0	5	0	**67**
	11 July*	5	1	0	1	0	0	0	0	0	5	0	**12**
	12 July*	9	27	21	0	0	0	1	0	0	6	0	**64**
1562-AS-030	10 July	10	36	5	0	0	0	1	0	0	17	2	**71**
	11 July*	4	2	0	0	0	0	0	0	0	0	0	**6**
	12 July*	11	44	3	0	17	0	3	0	0	25	3	**106**
	10 July	2	0	4	0	2	0	2	0	4	0	0	**14**

Site	Date (2020)	EPFU	LABO	LACI	LANO	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	Total/ Site
1562-AS-031	11 July*	0	0	0	0	0	0	1	0	1	0	0	**2**
	12 July*	1	1	2	0	0	0	0	0	9	1	0	**14**
1562-AS-032	10 July	37	3	14	1	0	0	2	0	1	5	0	**63**
	11 July*	3	0	0	0	0	0	0	0	0	0	0	**3**
	12 July*	4	7	4	1	0	0	1	0	0	8	1	**26**
Total Species		**1,618**	**1,553**	**636**	**74**	**144**	**1**	**194**	**2**	**34**	**500**	**256**	**5,012**

EPFU=*Eptesicus fuscus* (big brown bat); **LABO**=*Lasiurus borealis* (eastern red bat); **LACI**= *Lasiurus cinereus* (hoary bat); **LANO**= *Lasionycteris noctivagans* (silver-haired bat); **MYLE**=*Myotis leibii* (eastern small-footed bat), **MYGR**=*Myotis grisescens* (gray bat), **MYLU**=*Myotis lucifugus* (little brown bat); **MYSE**=*Myotis septentrionalis* (northern long-eared bat); **MYSO**=*Myotis sodalis* (Indiana bat); **NYHU**=*Nycticeius humeralis* (evening bat); **PESU**=*Perimyotis subflavus* (tricolored bat).
*Partial night due to bad weather (rain and/or high wind).

5.2 Maximum Likelihood Estimator

Table 4 provides results of the MLE analysis integrated into Kpro's analysis suite. As described in Section 4.1.4 above, analysis is a goodness of fit test comparing quantity and quality of recorded calls to known libraries of call sequences and known detection error rates for each species to estimate species presence probability.

Scores in the table range from a probability (p) = 1 (indicating the species was not identified in the analysis) to p = 0 (data contain many high-quality calls, thus the chance of error is low). Presence of a species is assumed on a given night with a $p<0.05$). Thus, Kpro analysis provided evidence of red and hoary bat presence at all sites, big brown bats at all sites except 1562-AS-18 and 1562-AS-31, and evidence of evening bats at 11 sites. The analysis failed to find support for the presence of silver-haired or eastern small-footed bats. Among target species, analysis revealed likely Indiana and northern long-eared bat presence at one site each, little brown bat presence at three sites, tricolored bat presence at eight sites, and gray bat presence at 17 sites.

5.3 Visual Vetting

The MLE values reported in Table 4 provide statistical evidence indicating the presence of the federally endangered Indiana and gray bat, as well as the federally threatened northern long-eared bat and two species under consideration for federal protection (tricolored and little brown bat) in the Houston South area. Each species and the evening bat are also considered endangered by Indiana Department of Natural Resources (IDNR) within Indiana. Based on listed bat presence, Mr. Moore reviewed files collected at all sites to determine likelihood of species presence and results of analysis are summarized in Table 5. Visual review found call sequences consistent with tricolored bats at 22 sites, little brown bats at 10, Indiana bats at 6, gray bats at 4, and northern long-eared and eastern small-footed bats present at a single site each (Table 5, Figure 3). Visual review found call sequences consistent with evening bats at 21 sites.

Table 4. Kaleidoscope Pro maximum likelihood estimator on Houston South Study Area in the Hoosier National Forest in Monroe, Jackson, and Lawrence counties, Indiana.

Site	Date (2020)	EPFU	LABO	LACI	LANO	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU
1562-AS-001	10 July	0	0	0.0000028	1	0	1	1	1	0.1347648	1	0
	11 July*	0	0.0541849	1	1	1	0.0538553	0.0474354	1	0.9998339	0.8598737	1
	12 July*	0	0	0.1663246	1	0.0000002	1	1	0.1275974	0.3396637	1	0
1562-AS-002	10 July	0.0054307	0.0002913	0.0000001	1	1	1	1	1	1	0.0015262	1
	11 July*	0.397991	0.0633201	0.0119436	1	1	1	1	1	1	1	1
	12 July*	1	0.2586744	0.0017521	0.9594514	0.0027226	1	1	1	0.4745202	0.0001208	1
1562-AS-003	10 July	0.039013	0.0000028	0.0007723	1	0.0052498	1	1	1	1	0.0000718	0.1061071
	11 July*	0.0640972	0.0113402	0.027312	1	1	1	0.5443216	1	1	1	1
	12 July*	0.0002448	0.0000347	0.0161514	1	0.0062605	1	0.9981781	1	1	0.0018744	1
1562-AS-005	10 July	0	0	0	1	1	1	0.9724117	1	1	0.6685206	1
	11 July*	0.007979	1	0.0472439	1	1	1	1	1	1	1	1
	12 July*	0.0000635	0.0015202	0	1	1	1	0.9324635	1	1	0.0015259	1
1562-AS-008	24 July	0.1583959	0	0.0001435	1	1	1	1	1	1	1	0.4897008
	25 July	0.1232774	0.0630668	1	1	1	1	1	1	1	1	1
	26 July*	0.0152185	0.0040673	1	1	1	1	0.7787595	1	1	0.6024909	1
1562-AS-09	10 July	0.0040686	0.0027077	0.0008814	1	1	1	1	1	1	0.0426678	0.5090582
	11 July*	0.0638425	0.0387335	0.0290916	1	0.0025583	1	1	1	1	0.3568932	0.306038
	12 July*	0.0000007	0.0001141	0.0000312	1	0.0181011	1	0.4440873	1	0.5538205	0	0.0025422
1562-AS-010	10 July	0.0001517	0	0.0000003	1	0.0145097	1	0.721494	1	1	0.434441	0.2905643
	11 July*	0.00378	0.0012562	0.3607892	1	1	1	1	1	1	0.9458222	0.2622474
	12 July*	0.0000004	0	1	1	0.0000169	1	1	1	1	1	0.0040632
1562-AS-011	10 July	0.0000001	0	0.001157	1	1	1	1	1	1	0.8660121	0.8473344
	11 July*	0.0020306	0.0027077	0.0092457	1	1	1	1	1	1	0.0426679	0.5090587
	12 July*	0.0000285	0.0000001	1	1	0.0054983	1	1	1	1	0.3025279	0.6876472
1562-AS-012	10 July	0.0071945	0.000016	0.0000769	1	1	1	0.2968789	1	0.5547522	0.0463684	1
	11 July*	1	1	0.061439	1	1	1	1	1	1	1	1
	12 July*	1	0.0004352	0.1006216	1	1	1	0.0771021	1	1	0.0034409	1
1562-AS-013	10 July	0	0	0	1	0.0001353	1	0.8703556	1	1	0.0458095	0.2066822
	11 July*	0.003444	1	0	1	1	1	1	1	1	1	1
	12 July*	0	0	0.0000014	1	0.0000725	1	1	1	1	0	1
1562-AS-014	10 July	0.8039608	0	0.000477	0.7202537	0	1	0.7539031	1	0.591879	1	0.041674
	11 July*	0.0018745	1	1	1	1	1	1	1	1	1	1
	12 July*	0.0002311	0.0002911	1	1	1	1	1	1	1	0.6742307	1

Site	Date (2020)	EPFU	LABO	LACI	LANO	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU
1562-AS-015	10 July	0	0	0	1	0	1	1	1	1	1	0.7647133
	11 July*	0	0.0002525	1	1	1	1	1	1	1	1	1
	12 July*	0	0	0.1446432	1	0	1	1	1	1	1	0.6577054
1562-AS-016	10 July	0	0	0	1	1	1	0.0596082	1	1	0.7796144	0.9992333
	11 July*	0	1	0.9997498	1	1	1	1	1	1	1	1
	12 July*	0	0	0	1	0.0000001	1	1	1	0.4456958	0.0433131	0.7658288
1562-AS-018	10 July	0.3908644	0.0002982	0	1	0.0025583	1	1	1	1	0.6752427	0.3972994
	11 July*	1	1	1	1	1	1	1	1	1	1	1
	12 July*	0.3976653	0.1950626	0.0125471	1	1	1	1	1	1	0.6172056	0.0091842
1562-AS-020	10 July	0.0001179	0	0	1	0	1	0.9640772	1	1	1	0
	11 July*	0.0005261	1	0.0013493	1	1	1	1	1	1	1	1
	12 July*	0	0.0040318	0	1	0	1	1	1	1	1	0
1562-AS-021	10 July	0	0	0.0521371	1	0.000003	1	0.5179809	1	1	0.9621799	1
	11 July*	0	0	0.0282553	1	0	1	0.0035365	1	1	1	1
	12 July*	0	0	0.3044809	1	0	1	0.3942313	1	0.8626725	1	1
1562-AS-022	10 July	0	0	0	1	0	1	0.0682673	1	0.1841596	1	0
	11 July*	0.0155929	0.0000146	0.399418	0.8877137	1	1	0.4776244	1	1	1	1
	12 July*	0.0000002	0	0	1	0	1	0.6001969	1	0.9520456	1	0.3827767
1562-AS-023	10 July	0.0118066	0.0000003	0	1	1	1	1	1	0.4905749	1	0.0049919
	11 July*	1	0.003619	0.001338	0.9609708	1	1	1	1	1	0.5209557	1
	12 July*	0.2529914	0	0.1652513	1	1	1	1	1	1	1	0.3597898
1562-AS-027	10 July	0	0	0	1	1	1	1	0.0233526	1	1	1
	11 July*	0	1	0.9181029	1	1	1	1	1	1	1	1
	12 July*	0	0	0	1	0.0032866	1	1	1	1	1	1
1562-AS-028	10 July	0	0.0000001	0	1	1	1	1	1	1	0.5492238	1
	11 July*	0	1	1	1	1	1	1	1	1	1	1
	12 July*	0	0.0000001	0.0000942	1	1	1	0.6227003	1	0.5233441	1	1
1562-AS-029	10 July	0.0000009	0	0.0050674	1	1	1	1	1	1	1	1
	11 July*	0.0002097	0.5914205	1	0.9217288	1	1	1	1	1	0.0024138	1
	12 July*	0.000634	0	0	1	1	1	1	1	1	1	1
1562-AS-030	10 July	0	0	0.0016963	1	1	1	1	1	1	0.0598341	0.8615211
	11 July*	0.0002309	0.0039815	1	1	1	1	1	1	1	1	1
	12 July*	0	0	0.0883996	1	0	1	1	1	1	0.0035513	0.8272536
1562-AS-031	10 July	0.1587436	1	0.0001446	1	0.0001015	1	0.0259828	1	0.0505586	1	1
	11 July*	1	1	1	1	1	1	0.115975	1	0.487536	1	1
	12 July*	0.3976648	0.195394	0.0125664	1	1	1	1	1	0.0010969	0.5956689	1

Site	Date (2020)	EPFU	LABO	LACI	LANO	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU
1562-AS-032	10 July	0	0.0253515	0.0000001	1	1	1	0.2740094	1	0.5201755	0.0338779	1
	11 July*	0.0018745	1	1	1	1	1	1	1	1	1	1
	12 July*	0.0067399	0.0000125	0.0010335	1	1	1	0.9994583	1	1	0.0158694	0.731945

EPFU=*Eptesicus fuscus* (big brown bat); **LABO**=*Lasiurus borealis* (eastern red bat); **LACI**= *Lasiurus cinereus* (hoary bat); **LANO**= *Lasionycteris noctivagans* (silvered-haired bat); **MYLE**=*Myotis leibii* (eastern small-footed bat); **MYGR**=*Myotis grisescens* (gray bat); **MYLU**=*Myotis lucifugus* (little brown bat); **MYSE**=*Myotis septentrionalis* (northern long-eared bat); **MYSO**=*Myotis sodalis* (Indiana bat); **NYHU**=*Nycticeius humeralis* (evening bat); **PESU**=*Perimyotis subflavus* (tricolored bat).
*Partial night due to bad weather (rain and/or high wind).

Table 5. Bat calls identified during visual review on the Houston South Study Area in the Hoosier National Forest in Monroe, Jackson, and Lawrence counties, Indiana.

Site	EPFU	LABO	LACI	LANO	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	# Species Present
1562-AS-001	C	C	C	P	A	C	C	P	C	C	C	8
1562-AS-002	C	C	C	A	A	A	C	A	A	C	A	5
1562-AS-003	C	C	C	A	A	A	A	A	A	C	C	5
1562-AS-005	C	C	C	A	A	A	A	A	A	A	C	4
1562-AS-008	C	C	C	A	A	A	A	A	C	C	C	6
1562-AS-009	C	C	C	A	A	A	A	A	A	C	C	5
1562-AS-010	C	C	C	A	A	A	C	A	C	A	C	6
1562-AS-011	C	C	C	P	C	A	A	A	A	C	C	6
1562-AS-012	C	C	C	A	A	P	A	A	A	C	C	5
1562-AS-013	C	C	C	A	A	A	A	A	A	C	C	5
1562-AS-014	C	C	C	A	A	A	C	A	P	C	C	6
1562-AS-015	C	C	C	P	C	A	A	A	A	C	C	6
1562-AS-016	C	C	C	A	C	A	A	A	A	C	C	6
1562-AS-018	C	C	C	A	A	A	A	A	A	C	C	5
1562-AS-020	C	C	C	P	A	A	C	A	C	C	C	7
1562-AS-021	C	C	C	P	A	A	C	A	C	C	C	7
1562-AS-022	C	C	C	C	C	A	C	A	A	C	C	8
1562-AS-023	C	C	C	P	A	A	C	A	A	C	C	6
1562-AS-027	C	C	C	A	A	A	P	A	A	C	C	5
1562-AS-028	C	C	C	A	A	A	C	A	P	C	C	6
1562-AS-029	C	C	C	P	A	A	A	A	A	C	A	4
1562-AS-030	C	C	C	A	A	A	P	P	A	C	C	5
1562-AS-031	C	C	C	A	A	A	C	C	C	A	C	7
1562-AS-032	C	C	C	A	A	A	P	A	A	C	C	5
#Confirmed Sites	**24**	**24**	**24**	**1**	**4**	**1**	**10**	**1**	**6**	**21**	**22**	

EPFU=*Eptesicus fuscus* (big brown bat); **LABO**=*Lasiurus borealis* (eastern red bat); **LACI**= *Lasiurus cinereus* (hoary bat); **LANO**= *Lasionycteris noctivagans* (silver-haired bat); **MYLE**=*Myotis leibii* (eastern small-footed bat), **MYGR**=*Myotis grisescens* (gray bat), **MYLU**=*Myotis lucifugus* (little brown bat); **MYSE**=*Myotis septentrionalis* (northern long-eared bat); **MYSO**=*Myotis sodalis* (Indiana bat); **NYHU**=*Nycticeius humeralis* (evening bat); **PESU**=*Perimyotis subflavus* (tricolored bat).
C = species confirmed present, **P** = species potentially present, **A** = species confirmed absent.

5.4 Habitat Assessment

Bat detectors are preferentially placed in open habitats where they can detect bats flying along nearby wooded edges. Thus, all but one habitat sheet (Appendix B) identified forest edge as a component of habitat present at the site. Roosting quality for Indiana and northern long-eared bats was generally moderate, but ranged from high to low. Dominant canopy species included chestnut (*Quercus montana)* white (*Quercus alba*) and red (*Quercus rubra*) oaks, sugar (*Acer saccharum*) and other maples, Tulip poplar (*Liriodendron tulipifera*), black walnut (*Juglans nigra*) and ashes (*Fraxinus sp.*). With the exception of white oak, the same species were often also subdominant members of canopy and the subcanopy along with sassafras (*Sassafras albidum*), and eastern white pine (*Pinus strobus*). Table 6 provides a summary of habitat.

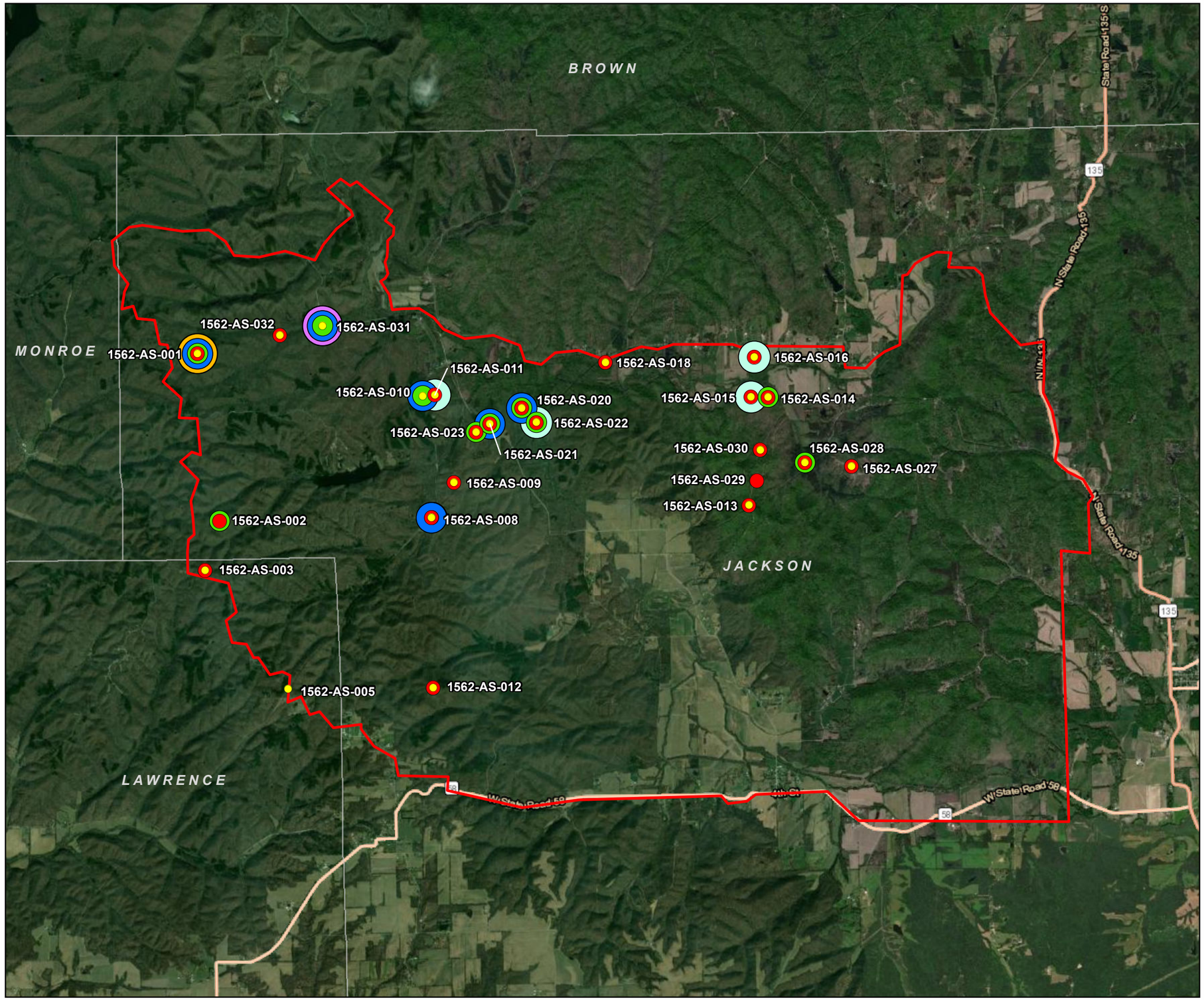


Figure 3. Detection locations of rare, threatened, or endangered bats in the Houston South Study Area on the Hoosier National Forest in Monroe, Jackson, and Lawrence counties, Indiana.

- Houston South Study Area
- County Boundary
- Tricolored Bat Detected (23)
- Evening Bat Detected (22)
- Little Brown Bat Detected (10)
- Indiana Bat Detected (7)
- Gray Bat Detected (4)
- Northern Long-eared Bat Detected (1)
- Eastern Small-footed Bat Detected (1)

N W E S

0 0.75 1.5 Miles

Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

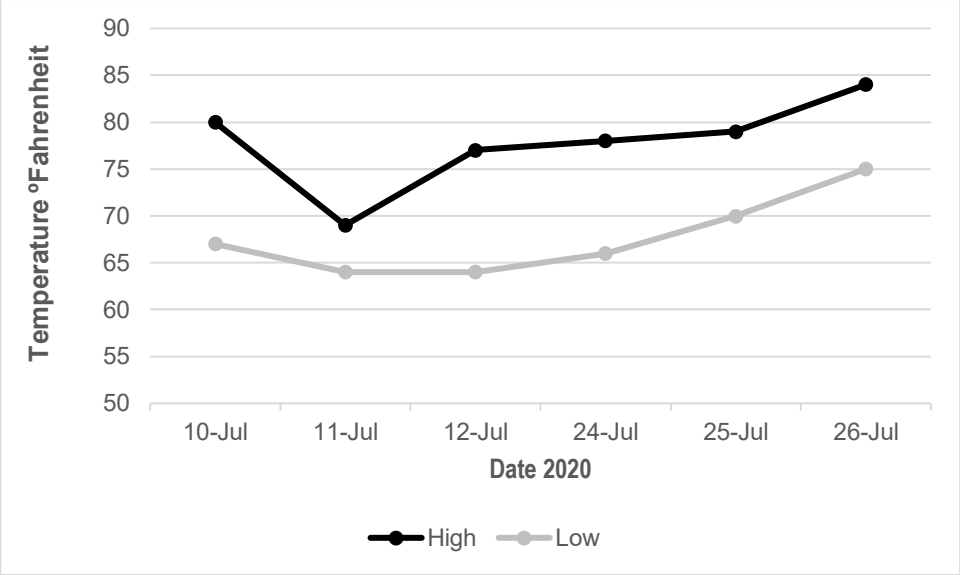
Project No. 1562

G:\Current\1562_Houston_South_HNF\Maps\Bat_Survey\Report_Figures\Figure3_1562_Bat_Detection_Locations_20200911.mxd; creator: thunter

5.5 Weather and Temperature

Weather data were obtained from the Indianapolis International Airport NOAA weather station (Appendix E; Figure 4). Weather conditions for the nights of 10, 24, and 25 July were consistent with recommended conditions for acoustic surveys. Conversely, strong storms and associated wind affected samples collected on 11 and 12 July, while 26 July was affected by strong winds. Temperatures throughout the survey were within recommended guidelines, indicating bats likely foraged during periods of suitable weather. Complete weather data are provided in Appendix E.

Figure 4. Hourly temperatures (˚F) during acoustic detector surveys on the Houston South Study Area in the Hoosier National Forest in Monroe, Jackson, and Lawrence counties, Indiana.



6.0 Discussion

6.1 Acoustic Monitoring

Acoustic monitoring suggests all eleven species of bats known to reside in Indiana can be found in the Houston South Study Area. If true, the area represents an important reservoir of chiropteran diversity at both the state and federal level.

Call sequences consistent with big brown, eastern red, and hoary bats were recorded and visually vetted at every site. The species are widely distributed in Indiana (Whitaker et al. 2007), not severely affected by WNS (Francl et al. 2012), and are detected during the vast majority of acoustic monitoring efforts (ESI Unpublished). Unexpectedly, call

Table 6. Habitat characteristics of acoustic sites in the Houston South Study Area in the Hoosier National Forest in Monroe, Jackson, and Lawrence counties, Indiana.

	Water Source		Tree Species				Clutter		MYSO Roost Tree		MYSE Roost Tree			
Net Site	Name	Distance (m)	Dominant Canopy	Subdominant Canopy	Subcanopy	Canopy Closure	Rating	Composition	Potential	Composition	Potential	Composition	Habitat Type	Herb. Cover
1562-AS-001	Unknown	10	*Quercus montana, Pinus strobus, Quercus rubra*	*Sassafras albidum, Fagus grandifolia, Cornus florida*	*Smilax sp., Parthenocissus sp., Toxicodendron radicans*	M	O	Saplings	M	Lrg trees & snags	H	Lrg trees & snags	MU, FE, DL/P	S
1562-AS-002	Unnamed stream	100	*Quercus rubra, Quercus montana, Fagus grandifolia*	*Sassafras albidum, Fagus grandifolia, Fraxinus sp.*	*Sassafras albidum, Fraxinus sp., Quercus montana*	M	M	Saplings	M	Hollow & Lrg trees & snags	M	Hollow & Lrg trees & snags	MU, YL, FE, OF	M
1562-AS-003	Starnes Branch	500	*Liriodendron tulipifera, Quercus rubra, Juglans nigra*	*Sassafras albidum, Acer saccharinum, Quercus rubra*	*Elaeagnus umbellata, Rhus sp., Acer saccharum*	M	M	Saplings	M	Lrg trees	L	Lrg trees	MU, YU, FE, OF	D
1562-AS-005	Unnamed pond	234	*Acer saccharum, Liriodendron tulipifera, Acer rubrum*	*Cercis canadensis, Liriodendron tulipifera, Acer rubrum*	*Acer rubrum, Rosa multiflora, Liriodendron tulipifera*	M	M	Saplings	M	Snags	L	Snags	YU, FE, OF	D
1562-AS-008	Unnamed wetland	176	*Liriodendron tulipifera, Pinus strobus, Acer saccharum*	*Robinia pseudoacacia, Rhus sp., Salix sp.*	*Robinia pseudoacacia, Rhus sp., Elaeagnus umbellata*	M	M	Saplings	M	Snags	L	Snags	YU, FE, OF	D
1562-AS-009	Unnamed waterbody	28	*Fraxinus sp., Juniperus virginiana, Quercus alba*	*Cornus sp., Acer rubrum, Rhus typhina*	*Rhus sp., Quercus alba, Acer rubrum*	M	M	Saplings	L	None	L	None	RLF, FE, OF	D
1562-AS-010	Unnamed waterbody	350	*Prunus serotina, Quercus alba, Juglans nigra*	*Fraxinus sp., Cornus florida, Juniperus virginiana*	*Rubus sp., Solidago sp., Asclepias sp.*	O	M	None	M	Lrg trees	M	Lrg trees	MU, FE, OF	D

	Water Source		Tree Species				Clutter		MYSO Roost Tree		MYSE Roost Tree			
Net Site	Name	Distance (m)	Dominant Canopy	Subdominant Canopy	Subcanopy	Canopy Closure	Rating	Composition	Potential	Composition	Potential	Composition	Habitat Type	Herb. Cover
1562-AS-011	Unnamed waterbody	350	*Quercus alba, Acer saccharum, Liriodendron tulipifera*	*Cornus florida, Sassafras albidum, Juniperus virginiana*	*Rubus sp., Fraxinus sp., Solidago sp.*	M	M	Shrubs & Saplings	M	Lrg trees & snags	M	Lrg trees & snags	MU, FE, OF	D
1562-AS-012	Unnamed pond	15	*Liriodendron tulipifera, Populus grandidentata, Pinus strobus*	*Fraxinus sp., Liriodendron tulipifera, Pinus strobus*	*Fraxinus sp., Liriodendron tulipifera, Quercus spp.*	M	M	Saplings	M	Lrg trees	L	Lrg trees	MU, YU, FE, OF	D
1562-AS-013	Unnamed waterbody	1460	*Quercus montana*	*Sassafras albidum, Quercus rubra*	*Sassafras albidum, Quercus rubra*	O	M	Branches & Saplings	M	Lrg trees	M	Lrg trees	YU, FE	D
1562-AS-014	Unnamed waterbody	260	*Acer saccharum*	*Pinus strobus*	*Pinus strobus, Platanus occidentalis*	M	M	Branches & Saplings	L	Lrg trees	M	Lrg trees	YU, WL	M
1562-AS-015	Unnamed waterbody	50	*Quercus montana, Quercus rubra*	*Juglans nigra, Pinus strobus, Liriodendron tulipifera*	*Pinus strobus, Juglans nigra, Liriodendron tulipifera*	M	M	Branches Shrubs & Saplings	M	Lrg trees & snags	M	Lrg trees & snags	YU, FE, DL/P	M
1562-AS-016	Unnamed waterbody	646		*Platanus occidentalis, Juglans nigra, Pinus strobus*	*Platanus occidentalis, Juglans nigra, Pinus strobus*	M	M	Branches Shrubs & Saplings	L	Lrg trees	M	Lrg trees	YU, FE, WL, C/P	M
1562-AS-018	Unnamed waterbody	1674	*Platanus occidentalis, Betula nigra, Acer rubrum*	*Liquidambar styraciflua, Acer rubrum, Liriodendron tulipifera*	*Liquidambar styraciflua, Acer rubrum*	M	M	Saplings	M	Hollow snags	M	Hollow snags	YL, FE, OF	D

	Water Source		Tree Species				Clutter		MYSO Roost Tree		MYSE Roost Tree			
Net Site	Name	Distance (m)	Dominant Canopy	Subdominant Canopy	Subcanopy	Canopy Closure	Rating	Composition	Potential	Composition	Potential	Composition	Habitat Type	Herb. Cover
1562-AS-020	Unnamed waterbody	0		*Betula alleghaniensis, Acer negundo, Acer rubrum*	*Acer negundo, Betula alleghaniensis, Nuphar sp.*	O	M	Shrubs & Saplings	H	Snags	H	Snags	ML, FE, S/R	M
1562-AS-021	Unnamed waterbody	300	*Prunus serotina, Pinus strobus, Juglans nigra*	*Cornus florida, Acer negundo, Fraxinus americana*	*Acer negundo, Cornus florida, Rosa multiflora*	C	C	Branches & Saplings	M	Lrg trees & snags	M	Lrg trees & snags	MU, FE	M
1562-AS-022	South Fork Salt Creek	5	*Liriodendron tulipifera, Platanus occidentalis, Acer saccharinum*	*Carpinus caroliniana, Betula alleghaniensis, Ulmus americana*	*Ambrosia sp., Solidago sp., Rosa multiflora*	C	M	Saplings	M	Hollow & Lrg trees & snags	H	Hollow & Lrg trees & snags	ML, FE, S/R	D
1562-AS-023	Unnamed waterbody	500	*Quercus alba, Liriodendron tulipifera, Acer saccharum*	*Cornus florida, Nyssa sylvatica, Juniperus virginiana*	*Nyssa sylvatica, Cornus sp., Rhus sp.*	C	M	Shrubs & Saplings	M	Lrg trees & snags	H	Lrg trees & snags	MU, FE,	D
1562-AS-027	Unnamed waterbody	1750	*Quercus alba*	*Quercus montana, Acer saccharum, Fagus grandifolia*	*Quercus montana, Acer saccharum, Fagus grandifolia*	M	M	Branches Shrubs & Saplings	M	Lrg trees & snags	M	Lrg trees & snags	YU	M
1562-AS-028	Unnamed waterbody	595		*Liriodendron tulipifera, Juglans nigra, Platanus occidentalis*	*Juglans nigra, Liriodendron tulipifera, Platanus occidentalis*	M	M	Branches & Saplings	L	Lrg trees	M	Lrg trees	YU, FE	D
1562-AS-029	Unnamed waterbody	1090	*Quercus montana*	*Quercus rubra, Liriodendron tulipifera, Acer rubrum*	*Quercus rubra, Liriodendron tulipifera, Acer rubrum*	M	M	Branches & Saplings	M	Lrg trees & snags	M	Lrg trees & snags	YU, FE	D

	Water Source		Tree Species				Clutter		MYSO Roost Tree		MYSE Roost Tree			
Net Site	Name	Distance (m)	Dominant Canopy	Subdominant Canopy	Subcanopy	Canopy Closure	Rating	Composition	Potential	Composition	Potential	Composition	Habitat Type	Herb. Cover
1562-AS-030	Unnamed waterbody	2074	*Quercus alba*	*Magnolia acuminata, Acer rubrum, Cornus florida*	*Acer rubrum, Cornus florida, Magnolia acuminata*	M	M	Branches & Saplings	M	Lrg trees & snags	M	Lrg trees & snags	YU, FE	M
1562-AS-031	Fleetwood Branch	3	*Platanus occidentalis, Liriodendron tulipifera, Juglans nigra*	*Carpinus caroliniana, Acer negundo, Cercis canadensis*	*Aesculus flava, Asimina triloba, Rubus sp.*	C	M	Shrubs & Saplings	H	Hollow & Lrg trees & snags	H	Hollow & Lrg trees & snags	ML, FE, S/R	D
1562-AS-032	Fleetwood Branch	50	*Liriodendron tulipifera, Juglans nigra, Prunus serotina*	*Liriodendron tulipifera, Acer rubrum, Carpinus caroliniana*		O	O	Saplings	M	Lrg trees & snags	H	Lrg trees & snags	ML, FE, OF	S

Tree/Shrub Species: red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), silver maple (*Acer saccharinum*), box elder (*Acer negundo*) yellow buckeye (*Aesculus flava*), ragweed (*Ambrosia* sp.), milkweed (*Asclepias* sp.), paw paw (*Asimina triloba*), sweet birch (*Betula alleghaniensis*), river birch (*Betula nigra*), American hornbeam (*Carpinus caroliniana*), red bud (*Cercis canadensis*), dogwood (*Cornus sp.),* Flowering dogwood (*Cornus florida*), autumn olive (*Elaeagnus umbellata*), American beech (*Fagus grandifolia*), ash (*Fraxinus* sp.), black walnut (*Juglans nigra*), eastern red cedar (*Juniperus virginiana*), sweet gum (*Liquidambar styraciflua*), tulip poplar (*Liriodendron tulipifera*), cucumber magnolia (*Magnolia acuminata*), water lilly (*Nuphar* sp.), black gum tupelo (*Nyssa sylvatica*), Virginia creeper (*Parthenocissus sp.*), eastern white pine (*Pinus strobus*), American sycamore (*Platanus occidentalis*), big-toothed aspen (*Populus grandidentata*), wild black cherry (*Prunus serotina*), oaks (*Quercus* spp), white oak (*Quercus alba*), chestnut oak (*Quercus montana*), northern red oak (*Quercus rubra*), sumac (*Rhus* sp.), staghorn sumac (*Rhus typhina*), black locust (*Robinia pseudoacacia*), multiflora rose (*Rosa multiflora*), blackberry (*Rubus* sp.), willow (*Salix*), sassafras (*Sassafras albidum*), green briar (Smilax sp.), goldenrod (*Solidago* sp), poison ivy (*Toxicodendron radicans*), American elm (*Ulmus americana*)
Canopy Closure/Subcanopy Clutter: C = Closed; M = Moderate, O = Open
Roost Potential Rating: MYSO = Indiana bat *(Myotis sodalis*); MYSE = (*Myotis septentrionalis*)
H = High; M = Moderate; L = Low
Habitat Type: C/P = Crop/Pasture, DL/P Deepwater Lake/Pond, ML = Mature Lowland Forest; YL = Young Lowland Forest; YU = Young Upland Forest, MU = Mature Upland Forest; FE = Forest Edge; OF = Old Field; S/R = Stream or River; WL = Woodlot, VP = Vernal Pool
Herb (Herbaceous) Cover: D = Dense, M = Moderate; S = Sparse

sequences consistent with tricolored bats and evening bats were recorded at 22 and 21 sites respectively. Although the tricolored bat was once common in HNF (Brack et al. 2004), populations throughout the country declined substantially following the arrival of WNS (Center for Biological Diversity and Defenders of Wildlife 2016). Evening bats are considered rare in Indiana, but can be locally abundant (Whitaker et al. 2007). Call sequences of evening bats are easily confused with those of eastern red bats (Britzke et al. 2011). As such, evening bats should not be considered present until one is captured within the study area. Both tricolored and evening bats are considered endangered by IDNR (IDNR 2020).

Call sequences consistent with little brown, Indiana, and gray bats were found at an intermediate number of sites. Visual analysis identified likely call sequences of little brown bats at ten sites. Like tricolored and northern long-eared bats, little brown bats were once common in the region (Brack et al. 2004) but are now considered endangered by IDNR (IDNR 2020). Open habitats used for acoustic studies provide high quality foraging habitat for the species (Bergeson et al. 2013), and may over-estimate its abundance. Indiana bats were never abundant in the HNF (Brack et al. 2004), and the species detection at six sites is consistent with its long-term scattered occurrence in the region and relatively stable population (USFWS 2019). Gray bats in Indiana are most closely associated with a mine in Clark County (Brack et al. 1984a), but the species' range expanded (Whitaker et al. 2001). Gray bat was previously captured during surveys on HNF (Brack et al. 2004). If mist net surveys are completed in 2021 gray, little brown, and Indiana bats should be targeted for capture and telemetry.

Visual review indicated three species, silver-haired, eastern small-footed, and northern long-eared bat were found at one site each. Silver-haired bats are rare in Indiana during the breeding season (Whitaker et al. 2007) with calls similar to the more abundant big brown bat (Betts 1998, Britzke et al. 2011). Summer captures previously occurred on HNF (Brack et al. 2004). At present, eastern small-footed bats were detected only at swarming and hibernation sites in Indiana (Gikas et al. 2009). Summer colonies of small-footed bats in Indiana are unknown, but likely found in rocky outcrops or areas of rocky debris similar to those observed in other states (Johnson and Gates 2008, Johnson et al. 2011, Whitby et al. 2013). Any eastern small-footed bats captured during subsequent studies should be tracked to their roosts. Finally, the confirmation of northern long-eared bat call sequences at one site and potential detection at two other sites is a stark reminder of how this once common regional resident of deep forests has declined following the arrival of WNS. Any captured northern long-eared bats in subsequent studies should also be followed to their roosts.

6.2 Conclusion

Acoustic monitoring of 24 sites within the Houston South Study Area provided evidence of a diverse community of bats including five species listed or under review for listing under the ESA. The significant to severe declines in populations of these five myotis

species as a result of White Nose Syndrome, underscores the importance of their presence in the Houston South Area. Furthermore the bat community at Houston South potentially includes all eleven species suspected of being year-round residents of Indiana. Follow-up studies using mist nets and telemetry are planned for 2021. Studies should continue to focus on those species considered rare or endangered at either the state or federal level.

7.0 Literature Cited

Bergeson, S. M., T. C. Carter, and M. D. Whitby. 2013. Partitioning of foraging resources between sympatric Indiana and little brown bats. Journal of Mammology 94:1311-1320.

Betts, B. J. 1998. Effects of interindividual variation in echolocation calls on identification of big brown and silver-haired bats. Journal of Wildlife Management 62:1003-1010.

Brack, V., Jr., R. E. Mumford, and V. R. Holmes. 1984a. The gray bat (*Myotis grisescens*) in Indiana. American Midland Naturalist 111:205.

Brack, V., Jr., J. O. Whitaker, Jr., and S. E. Pruitt. 2004. Bats of Hoosier National Forest. Proceedings of the Indiana Academy of Science 113:78-86.

Brack, V., Jr., A. M. Wilkinson, and R. E. Mumford. 1984b. Hibernacula of the endangered Indiana bat in Indiana. Proceedings of the Indiana Academy of Science 93:463-468.

Britzke, E. R. 2004. Acoustic surveys of bats in the eastern United States. *in* Indiana Bat and Coal Mining, A Technical Interactive Forum (K.C. Vories and A. Harrington, eds.) U.S. Department of Interior, Office of Surface Mining. Alton, Illinois.

Britzke, E. R., J. E. Duchamp, K. L. Murray, R. K. Swihart, and L. W. Robbins. 2011. Acoustic identification of bats in the eastern United States: A comparison of parametric and nonparametric methods. Journal of Wildlife Management 73:660–667.

Broders, H. G., C. S. Findlay, and L. Zheng. 2004. Effects of clutter on echolocation call structure of *Myotis septentrionalis* and *M. lucifugus*. Journal of Mammalogy 85:273–281.

Broders, H. G., D. F. McAlpine, and G. J. Forbes. 2001. Status of the eastern pipistrelle (*Pipistrellus subflavus)* (Chiroptera: Vespertilionidae) in New Brunswick. Northeastern Naturalist 8:331-336.

Center for Biological Diversity and Defenders of Wildlife. 2016. Petition to list the tricolored bat *Perimyotis subflavus* as threatened or endangered under the Endangered Species Act. Petition submitted to the U.S. Secretary of the Interior, acting through the U.S. Fish and Wildlife Service. The Center for Biological Diversity, Tucson, Arizona and Defenders of Wildlife, Washington D.C. 76pp.

Culver, D. C., H. H. Hobbs, III, M. C. Christman, and L. L. Master. 1999. Distribution map of caves and cave animals in the United States. Journal of Cave and Karst Studies 61:139-140.

Damm, J. P. and K. Geluso. 2008. Use of a mine by eastern pipistrelles in east-central Nebraska. Western North American Naturalist 68:382-389.

Fenton, M. B. and R. M. R. Barclay. 1980. *Myotis lucifugus*. Mammalian Species 142:1-8.

Francl, K. E., W. M. Ford, D. W. Sparks, and V. Brack, Jr. 2012. Capture and reproductive trends of summer bat communities in West Virginia: assessing the impact of white nose syndrome. Journal of Fish and Wildlife Management 3:33-42.

Geluso, K., T. R. Mollhagen, J. M. Tigner, and M. A. Bogan. 2005. Westward expansion of the eastern pipistrelle (*Pipistrellus subflavus*) in the United States, including new records from New Mexico, South Dakota, and Texas. Western North American Naturalist 65:405-409.

Gikas, N. S., J. G. Boyles, A. A. Zurcher, B. L. Walters, and J. Whitaker J O. 2009. The first records of the eastern small-footed bat (*Myotis leibii*) in Indiana. Proceedings of the Indiana Academy of Science 118:203-204.

Humphries, M. H., D. W. Thomas, and J. R. Speakman. 2002. Climate-mediated energetic constraints on the distribution of hibernating mammals. Nature 418:313-316.

Humphries, M. M., J. R. Speakman, and D. W. Thomas. 2006. Temperature, hibernation energetics, and the cave and continental distributions of little brown myotis. Pages 23-37 *in* Functional and Evolutionary Ecology of Bats (A. Zubaid, G. F. McCracken, and T. Kunz, eds.). Oxford University Press, Oxford, United Kingdom. 360 pp.

IDNR. 2020. List of endangered, threatened, & rare species by county. Indiana Department of Natural Resources, Division of Nature Preserves, Natural Heritage Data Center, Indianapolis, Indiana. Available at: https://www.in.gov/dnr/naturepreserve/4666.htm.

Johnson, J. B. and J. E. Gates. 2008. Spring migration and roost selection of female *Myotis leibii* in Maryland. Northeastern Naturalist 15:453–460.

Johnson, J. S., J. D. Kiser, K. S. Watrous, and T. S. Peterson. 2011. Day-Roosts of *Myotis leibii* in the Appalachian Ridge and Valley of West Virginia. Northeastern Naturalist 18:95–106.

Johnson, S. A., V. Brack, Jr., and R. K. Dunlap. 2002. Management of hibernacula in the state of Indiana. Pages 100-109 *in* The Indiana Bat: Biology and Management of an Endangered Species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas.

Johnson, S. A., V. Brack, Jr., and R. E. Rolley. 1998. Overwinter weight loss of Indiana bats (*Myotis sodalis*) from hibernacula subject to human visitation. American Midland Naturalist 139:255-261.

Kunz, T. H. and J. Reichard. 2010. Status review of the little brown myotis (*Myotis lucifugus*) and determination that immediate listing under the endangered

species act is scientifically and legally warranted. Boston University's Center for Ecology and Conservation Biology.

Sheets, J. J., J. O. Whitaker Jr., V. Brack Jr., and D. W. Sparks. 2013. Bats of the hardwood ecosystem experiment before timber harvest: assessment and prognosis. Pages 191-202 *in* The Hardwood Ecosystem Experiment: a framework for studying responses to forest management (R. K. Swihart, M. R. Saunders, R. A. Kalb, G. S. Haulton, C. H. Michler, eds.). General Technical Report NRS-P-108. U.S. Department of Agriculture, Forest Service, Northern Research Station. Newtown Square, Pennsylvania.

Sparks, D. W. and J. R. Choate. 2000. Distribution, natural history, conservation status, and biogeography of bats in Kansas. Pages 173-228 *in* Reflections of a naturalist: Papers honoring professor Eugene D. Fleharty (J. R. Choate, ed.). Fort Hays Studies, Special Issue 1:1-241.

USFS. 2005. Mark Twain National Forest, Missouri: Programmatic biological assessment forest plan revision. U.S. Department of Agriculture, Forest Service, Eastern Region, Milwaukee, Wisconsin. 303 pp.

USFWS. 2007. Indiana bat (*Myotis sodalis*) draft recovery plan: First revision. U.S. Department of Interior, Fish and Wildlife Service, Fort Snelling, Minnesota. 258 pp.

USFWS. 2013. Northern long-eared bat (*Myotis septentrionalis*) fact sheet. U.S. Department of Interior, Fish and Wildlife Service.

USFWS. 2016. Programmatic biological opinion on final 4(d) rule for the northern long-eared bat and activities excepted from take prohibitions. U.S. Department of the Interior, Fish and Wildlife Service, Midwest Regional Office, Bloomington, Minnesota. 103 pp.

USFWS. 2017. Endangered and threatened wildlife and plants; 90-day findings for five species. Pages 60362-60366 *in* Federal Register Volume 82, No. 243. U.S. Department of the Interior, Fish and Wildlife Service.

USFWS. 2019. 2019 Indiana bat (*Myotis sodalis*) population status update. U.S. Department of the Interior, Fish and Wildlife Service, Indiana Ecological Services Field Office, Bloomington, Indiana. 9 pp.

USFWS. 2020a. Range-wide Indiana bat survey guidelines - March 2020. U.S. Department of the Interior, Fish and Wildlife Service. 65pp.

USFWS. 2020b. Three bat species assessment. Email from John Jaka, U.S. Department of Interior, Fish and Wildlife Service, Great Lakes Regional Office, Bloomington, Minnesota to Midwest Conservation Partners.

Valdez, E. W., K. Geluso, J. Foote, G. Allison-Kosior, and D. M. Roemer. 2009. Spring and winter records of the eastern pipistrelle (*Perimyotis subflavus*) in southeastern New Mexico. Western North American Naturalist 69:396-398.

Whitaker, J. O., Jr., V. Brack, Jr., D. W. Sparks, J. B. Cope, and S. Johnson. 2007. Bats of Indiana. Publication number 1. Indiana State University, Center for North American Bat Research and Conservation. 59 pp.

Whitaker, J. O., Jr., J. B. Cope, and V. Brack, Jr. 2003. Bats of Wyandotte Cave, Crawford County, Indiana. Proceedings of the Indiana Academy of Science 112:75-84.

Whitaker, J. O., Jr., L. Pruitt, and S. Pruitt. 2001. The gray bat, *Myotis grisescens*, in Indiana. Proceedings of the Indiana Academy of Science 110:114-122.

Whitby, M., S. Bergeson, T. Carter, S. Rutan, and R. McClanahan. 2013. The discovery of a reproductive population of eastern small-footed bat, *Myotis leibii*, in southern Illinois using a novel survey method. The American Midland Naturalist 169:229-233.

White, J. A., J. Moosman, P, C. H. Kilgore, and T. L. Best. 2006. First record of the eastern pipistrelle (*Pipistrellus subflavus*) from southern New Mexico. The Southwestern Naturalist 51:420-422.

APPENDIX A
LIFE HISTORY AND ECOLOGY OF TARGET BAT SPECIES

TABLE OF CONTENTS

ESI

LIST OF FIGURES

1.0 Indiana Bat (*Myotis sodalis*)

1.1 Description

The Indiana bat is a medium-sized bat in the genus *Myotis*. The forearm length has a range of 35 to 41 millimeters (1.4 – 1.6 in). The head and body length range from 41 to 49 millimeters (1.6 – 1.9 in). Winter weights range from 7.1 to 7.5 grams (0.25 to 0.26 oz). Its appearance most closely resembles that of congeners little brown bat (*M. lucifugus*) and northern long-eared bat. Indiana bats differ from similar *Myotis* species in that they have a distinctly keeled calcar (cartilage that extends from the ankle to support the tail membrane). Other minor differences include smaller and more delicate hind feet, shorter hairs on the feet that do not extend past the toenails, and a pink nose. The fur lacks luster, and the wing and ear membranes have a dull, flat coloration that does not contrast with the fur (USFWS 2007). Fur on the chest and belly is lighter than fur on the back, but is not as strongly contrasting as that of similar *Myotis* species. Overall color is slightly grayer, while the little brown bat and northern long-eared bat are browner. The skull has a crest and tends to be smaller, flatter, and narrower than that of the little brown bat (USFWS 2007) .

1.1.1 Status

The U.S. Fish and Wildlife Service (USFWS) listed the Indiana bat as endangered on 11 March 1967. The most current range-wide estimate of the population is 537,297 individuals, representing about 60 percent of the estimated population of 1960 (USFWS 2019). Long-term, detailed documentation of population changes are lacking across most of its range, with the exception of the state of Indiana (Brack et al. 1984b, Johnson et al. 2002b, Whitaker et al. 2003), although such information is now being acquired in most states. It is probable that habitat loss during summer (USFWS 2007) and winter disturbances during hibernation (Johnson et al. 1998) both contributed to the overall decline of the species that lead to listing.

With the arrival of WNS, this species has undergone significant population declines. Populations in the Appalachian and Northeastern Recovery Units have suffered the greatest declines. The Northeast Recovery Unit contained approximately 50,000 bats at the arrival of WNS, but contained approximately 13,500 bats in 2019 (USFWS 2019). The Appalachian Recovery Unit contained approximately 32,500 bats in 2011 but contained less than 2000 bats by 2019. In Indiana and the rest of the Midwest population declines have been less substantial. The Indiana population contained 225,477 in 2011 and declined to 180,611 by 2017 before rebounding slightly to 184,848 bats in 2019. In Indiana, these count changes have also been associated with a shift of bats from the northern-most hibernacula in the state to more southern hibernacula.

1.2 Ecology

The Indiana bat is a "tree bat" in summer and a "cave bat" in winter. There are four ecologically distinct components of the annual life cycle: winter hibernation, spring staging and autumn swarming, spring and autumn migration, and the summer season of reproduction. The U.S. Fish & Wildlife Service (USFWS) Recovery Plan (2007) provides a description of the life history. Figure 1 provides an annual chronology of seasonal activities.

1.2.1 Summer Roosting Ecology

The summer range of the Indiana bat is large and includes much of the eastern deciduous forestlands between the Appalachian Mountains and Midwest prairies (Figure 2). Distribution throughout the range is not uniform and summer occurrences are more frequent in southern Iowa and Michigan, northern Missouri, Illinois, and Indiana. Greater tree densities do not equate to more bats (Brack et al. 2002). Cooler summer temperatures associated with latitude or altitude likely affect reproductive success and the summer distribution of the species (Brack et al. 2002).

1.2.1.1 Males

Some males remain near hibernacula throughout summer while others migrate varying distances (Whitaker and Brack 2002). Males can be caught at hibernacula on most nights during summer (Brack 1983, Brack and LaVal 1985), although there may be a large turnover of individuals between nights (Brack 1983). Woodland roosts appear similar to maternity roosts (Kiser and Elliott 1996, Schultes and Elliott 2002, Brack and Whitaker 2004, Brack et al. 2004), although smaller diameter trees may be used. Less space may be required for a single bat than a colony of bats, or thermal requirements may differ. Males appear somewhat nomadic; over time, the number of roosts and the size of an area used increases. Activity areas encompass roads of all sizes, from trails to interstate highways. Roosts have also been located near roads of all sizes (Kiser and Elliott 1996, Schultes and Elliott 2002, Brack et al. 2004), including adjacent an interstate highway (Brack et al. 2004).

1.2.1.2 Females and Maternity Colonies

When female Indiana bats emerge from hibernation, they migrate to maternity colonies that may be located up to several hundred miles away (Kurta and Murray 2002). Females form nursery colonies under exfoliating bark of dead, dying, and living trees in a variety of habitat types, including uplands and riparian habitats. A wide variety of tree species, including occasional pines (Britzke et al. 2003) are used as nursery colonies indicating that it is tree form, not species that is important for roosts. Since many roosts are in dead or dying trees, they are often ephemeral. Roost trees may be

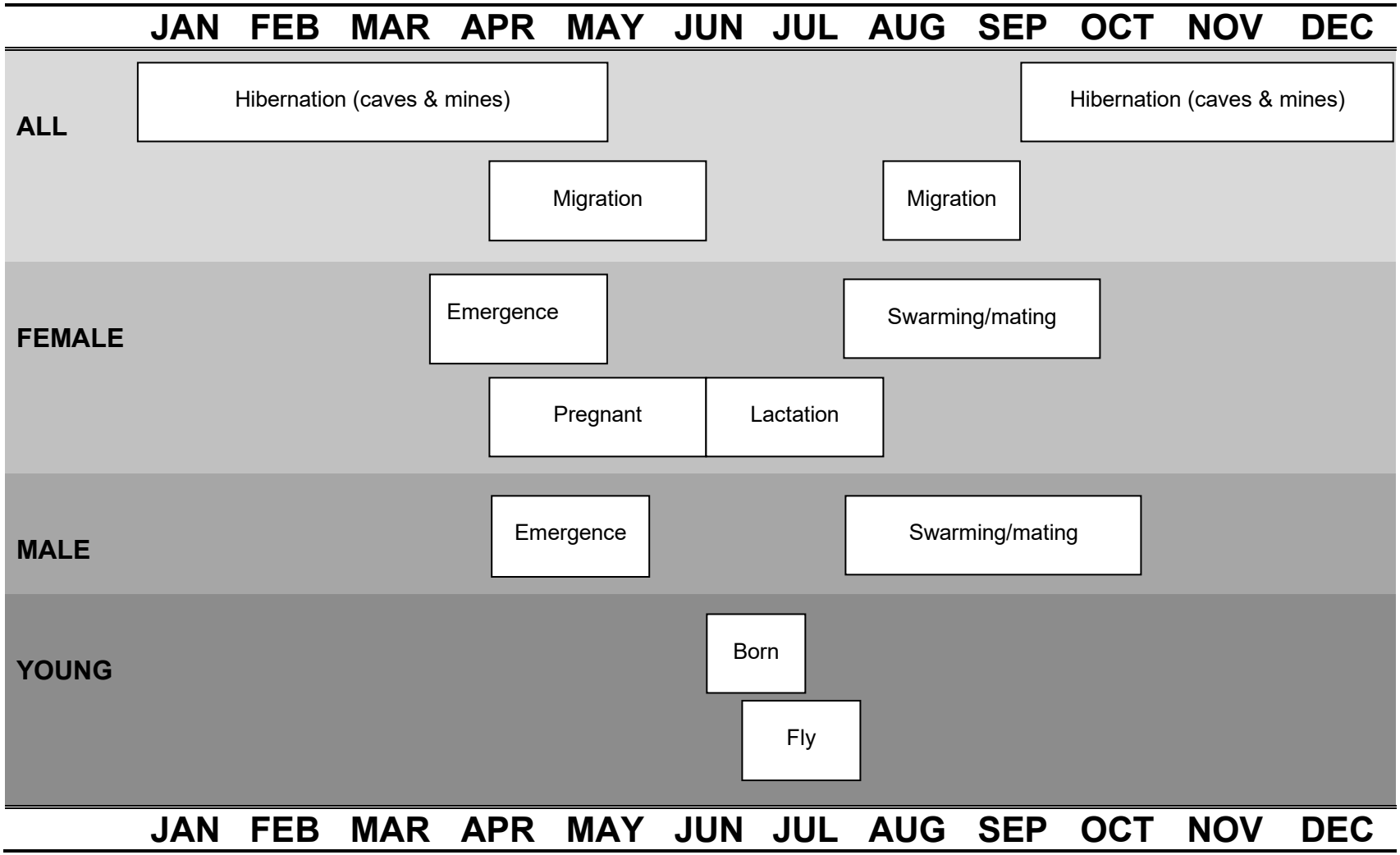


Figure 1. Seasonal chronology of Indiana bat activities.

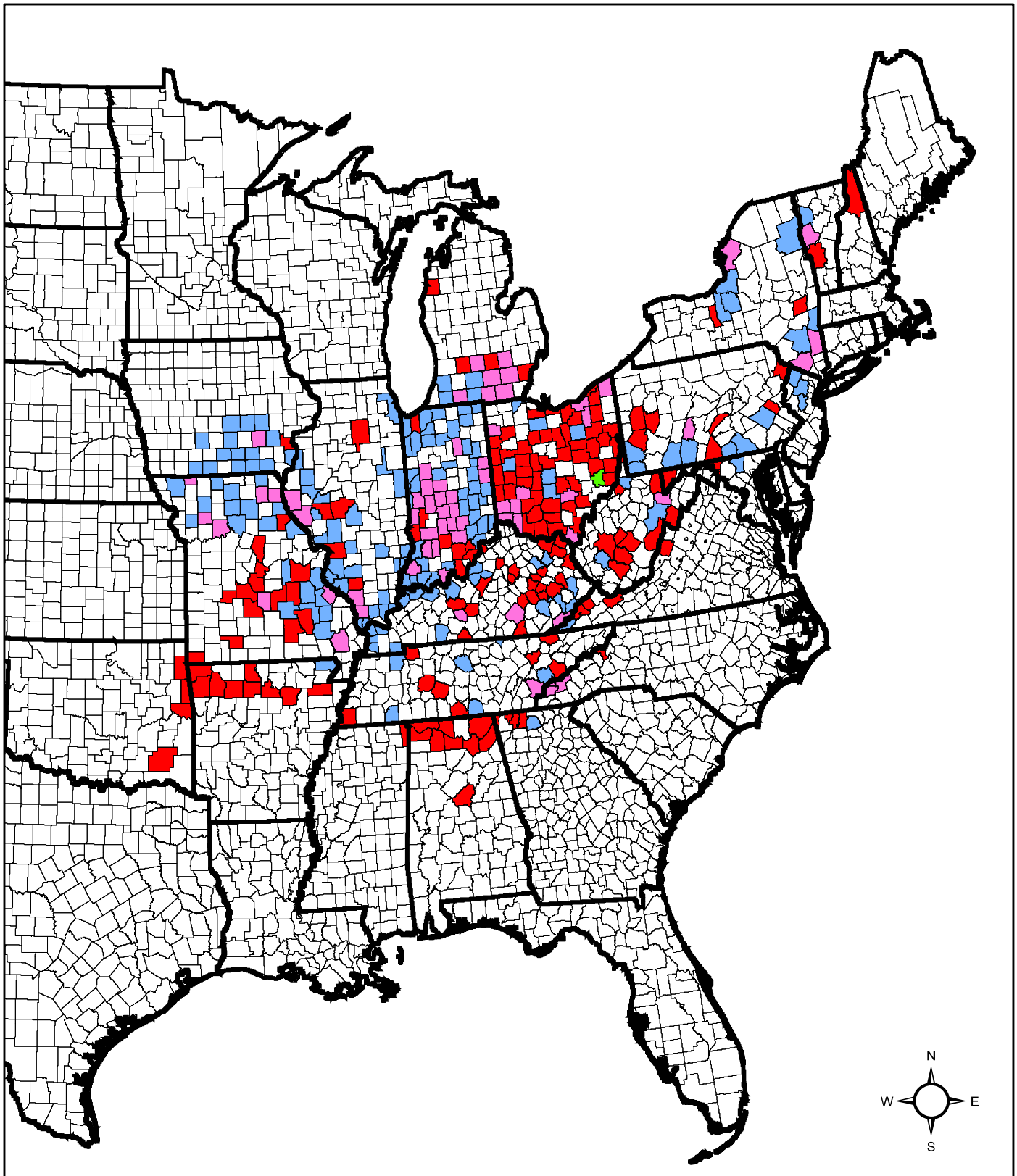


Figure 2. Rangewide distribution of the Indiana bat during summer, showing counties with reproductive (adult female and/or young-of-the-year) and non-reproductive records.

County with Record of Indiana Bat Reproductive Occurrence	County with Record of Indiana Bat Summer Non-Reproductive Occurrence	County with Record of Indiana Bat Reproductive and Summer Non-Reproductive Occurrence	County with Record of a Visually Confirmed Indiana Bat Call Sequence

Project No. 000	Sources: USFWS, Indiana Bat Revised Recovery Plan, Agency Draft, 2007. Updated: November 2014	ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

habitable for one to several years, depending on the species and condition of the tree (Callahan et al. 1997) Indiana bats exhibit strong site fidelity to summer roosting and foraging areas (Kurta and Murray 2002, Kurta et al. 2002). Females are pregnant when they arrive at maternity roosts. Parturition typically occurs between late June and early July. A maternity colony typically consists of 25 to 325 adult females. Nursery colonies often use several roost trees (Kurta et al. 1993, Foster and Kurta 1999, Kurta and Murray 2002), moving among roosts within a season. Most members of a colony coalesce into a single roost tree about the time of parturition, which begins to break up again as soon as young are volant. Roosts that contain large numbers of bats (more than 20 bats) are often called primary roosts, while secondary roosts hold fewer bats. Primary roost trees are often large dead or dying trees greater than 46 centimeters (18 in) diameter at breast height (dbh) and secondary roost trees are often greater than 23 centimeters (9 in) dbh (Gardner et al. 1991, Callahan et al. 1997, Kurta et al. 2002, Miller et al. 2002, Carter 2003). Numerous suitable roosts may be required to support a single nursery colony, possibly about 45 stems per hectare (20/acre) (Gardner et al. 1991, Miller et al. 2002, Carter 2003). Based on the need for multiple potential roosts, stands containing older or damaged trees are used preferentially.

Roost trees are often located where they have solar exposure, with 20 to 80 percent canopy closure (Humphrey et al. 1977, Gardner et al. 1991, Kurta et al. 1993, Kurta et al. 1996, Kurta et al. 2002, Carter 2003), and are often exposed to 10 or more hours of solar radiation per day (Kurta et al. 2002). The need for solar exposure may vary with latitude.

Indiana bats live on anthropogenic landscapes and recent research indicates females do include roads in their active area. Although bats do cross roads, the studies that document this behavior were not designed to gauge a graded response (Gardner et al. 1991, Brown et al. 2001, Kiser et al. 2002, Kurta et al. 2002, Brack and Whitaker 2006).

1.2.2 Food Habits and Foraging Ecology

Like many other species of microchiropterans, the Indiana bat often uses travel corridors that consist of open flyways such as streams, woodland trails, small infrequently used roads, and possibly utility corridors, regardless of suitability for foraging or roosting (Brown and Brack 2003). Members of maternity colonies forage in a variety of woodland settings, including upland and floodplain forest (Humphrey et al. 1977, Brack 1983, Gardner et al. 1991). Foraging activity is concentrated above and around foliage surfaces, such as over the canopy in upland and riparian woods, around crowns of individual or widely spaced trees, and along edges. They forage less frequently over old fields, and occasionally over bushes in open pastures. Forest edges, small openings, and woodlands with patchy trees provide more foraging opportunities than dense woodlands. Most species of woodland bats forage prominently along edges, less in openings, and least within forests (Grindal 1996). Openings also provide a better supply of insects than do wooded areas (Tibbels and Kurta 2003).

2.0 Gray Bat (*Myotis grisescens*)

2.1 Description

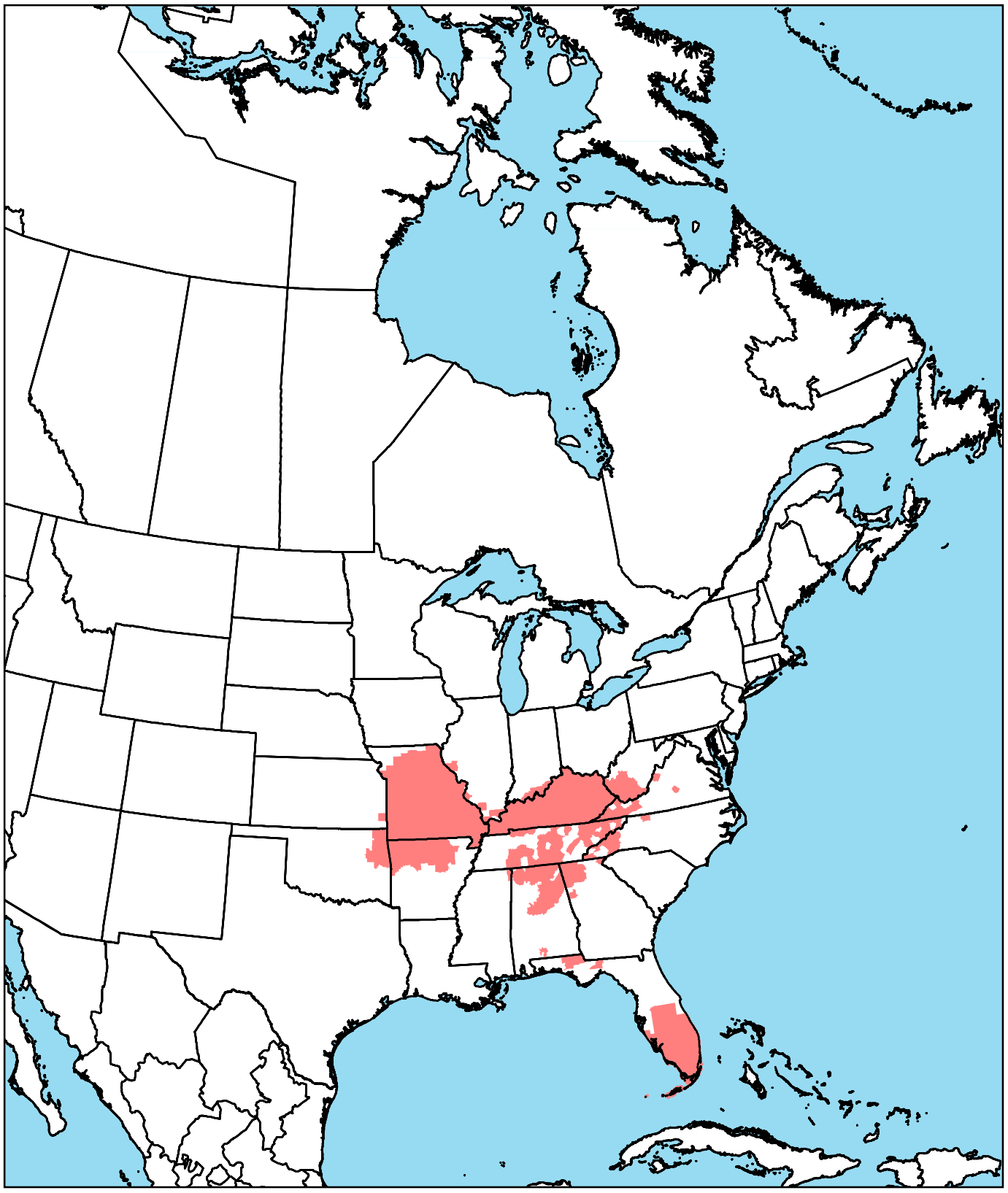
The gray bat (*Myotis grisescens*) is a monotypic species that occupies a limited geographic range in limestone karst areas of the southeastern U.S. (Figure 3). Most gray bat populations occur in Alabama, Arkansas, Kentucky, Missouri and Tennessee (Barbour and Davis 1969) with small maternity populations as far north as southern Indiana (Brack et al. 1984a) and as far west as southeastern Kansas (USFWS 1997).

The gray bat weighs about 10 grams (0.35 oz) at maturity and its right forearm measures about 40.5 – 45.5 millimeters (1.6 – 1.8 in). The wing membrane connects to the foot at the ankle rather than at the base of the first toe, as in other species of *Myotis*. The gray bat is monochromatic, i.e., the fur is one color – gray. However, young and newly molted individuals are a bright silvery gray whereas just before molt, the fur may be anywhere between a darker gray to blondish or russet color. Color changes are due to environmental factors, with lighter colors the result of bleaching from the ammonia in urine, and thus may be most pronounced in reproductive females.

2.2 Status

On 28 April 1976, the gray bat was listed as endangered under the Endangered Species Act (ESA) of 1973. A recovery plan for the species was completed on 1 July 1982 (Brady et al. 1982). Critical habitat was not designated.

When the gray bat was listed as federally endangered, there were approximately 128,000 individuals. Range-wide, the gray bat population has seen a 62 percent increase over the last 20 years (USFS 2005). Available population estimates are approximately 3.4 million individuals or greater (Martin 2007). In 2017, FWS developed a minimum population estimate of 4,486,263 gray bats (S. Marquardt, personal communication). All available metrics indicate gray bats are increasing in both population and range. This pattern is mirrored in Indiana. Regular presence of hibernating gray bats likely dates to 2009. Multiple gray bats were counted in subsequent counts reaching 1,380 gray bats in 2019 (D. Brack, Personal Communication). Cave protection measures instituted for the conservation of gray and



N
W E
S

Figure 3. Rangewide distribution of the gray bat.

Project No. 1562

0 360 720 Miles

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

other bats have been largely successful and populations at 73 percent of all caves are stable or increasing. Seventy-nine percent of gray bat colonies in the western portion of their range are stable or increasing.

2.3 Ecology

2.3.1 Winter Hibernation and Summer Roosting

Gray bats are true “cave bats” requiring caves for winter hibernation and summer roosting. Gray bats migrate seasonally, and hibernacula may be hundreds of miles from summer roosts. Tuttle (1976a) found bats traveled distances of 16 to 523 kilometers (10 - 325 mi) from winter hibernacula to summer ranges, but in the western portion of their range, migration distances are much shorter (Sasse et al. 2007). Hibernacula used by gray bats typically have a strong vertical component (the farther south the steeper the vertical component) with domed rooms that trap cold air with temperatures ranging from 6° to 11.6° Celsius (43° - 52°F) (Tuttle 1976a; 1979). Mating begins soon after adults arrive at hibernacula in autumn and females begin hibernating immediately thereafter. Females may begin hibernation by early September. Adult males and juveniles remain active for several weeks but are usually hibernating by early November. Hibernation continues through April (Brady et al. 1982).

Females store sperm over the winter, become pregnant soon after emerging from hibernation, and give birth to a single young by late May or early June (Brady et al. 1982). Colony members are loyal to the colony home range, but tend to disperse in groups among several different caves within an area (Brady et al. 1982). Males form bachelor colonies in spring (late March to mid-May), although many remain with females until young are born. During the reproductive season, adult males roost in different caves (or in different sections of maternity caves) than adult females and usually begin roosting together again after young become volant (Brady et al. 1982). Maternity colonies are formed in caves with domed ceilings that trap warm air with temperatures ranging from 14° to 26° Celsius (57° - 79°F) (Tuttle 1976a). Caves often contain underground streams and are usually within 1 to 4 kilometers (0.6 - 2.5 mi) of rivers or other bodies of water (Tuttle 1976b, USFWS 1997). Occasionally, summer roosts have been found in storm sewers (Decher and Choate 1995), mines (Brack et al. 1984b), railroad tunnels, dams, buildings (Evans and Drilling 1992), and bridges (Johnson et al. 2002a, Cervone and Yeager 2016). Gray bats use a wide variety of caves during spring and fall transient periods.

2.3.2 Food Habits and Foraging Ecology

The gray bat is generally associated with streams and wetlands (Brady et al. 1982, Clawson and Titus 1992) and commonly forages over wooded riparian corridors, often low over the water. Forested areas surrounding caves, flyways, and foraging areas are also important to the survival of gray bats (Tuttle 1979) and are routinely used while foraging, particularly by juveniles (Brack and Laval 2006). Depending upon colony size and available habitat, gray bats can forage up to 70 kilometers (43.5 mi) from roost

sites (LaVal et al. 1977) within a home range of 600.0 to 126,400.0 hectares (1,482.6 to 312,341.2 ac) (Moore et al. 2017). However, Tuttle (1976a) suggested that growth rates of young may be reduced as the distance from roosts to foraging areas increases. Adult females often feed more on aquatic insects (Orders Trichoptera [Caddisflies], Plecoptera [stoneflies], Ephemeroptera [Mayflies], and Diptera [true flies]) while juveniles forage more in woodlands and eat more terrestrial insects (Orders Lepidoptera [moths], Coleoptera [beetles], Heteroptera [true bugs], and Hymenoptera [wasps and ants]) (Brack and Laval 2006). One reason juveniles foraged more in woodlands and ate more coleopterans than adults may be that the coleopterans provide a greater energy reward per unit of capture effort. Best and Milam (1997) reported that insects from the orders Lepidoptera, Diptera, and Coleoptera were the primary prey of gray bats in Alabama. Lacki et al (1995) reported a similar diet in Kentucky.

Although gray bats often forage over waterways such as streams, rivers, and lakes (Tuttle 1976b, LaVal et al. 1977, Best and Hudson 1996), specific macro-habitat characteristics of waterways and surrounding lands important to gray bats are uncertain and may vary by landscape context and colony (Moore et al. 2017). Moreover, bat activity levels in forested riparian areas are higher than in non-forested riparian areas, especially with regard to most Myotids (Hayes and Adam 1996).

In Missouri, diets were compared to insect availability (Brack and Laval 2006). Proportional availability of insects varied among locations, over the season, between seasons, and between early-evening and late-night samples. Similarly, the diet varied among locations, over time, between early and late samples, and among sample groups by sex, age, and reproductive condition. However, there was poor correlation between corresponding diet and insect samples. Gray bats forage individually over long distances along streams and wooded riparian habitats. While this habitat produces a characteristic assemblage of insect prey, proportional availability varies temporally and spatially. Thus, although specific diet samples do not match corresponding insect samples, on a broader scale, diets and insect availability do correspond. On a micro-scale, the gray bat is an opportunistic forager, feeding on readily available prey, but on a macro-scale is selective, feeding in aquatic-based habitats where specific types of insect prey are abundant.

2.4 Causes of Past/Current Decline

Despite their wide-spread recovery (see Section 2.2) the gray bat continues to face several conservation challenges. The recovery plan (Brady et al. 1982) lists human disturbance, environmental disturbance (largely pesticides), impoundment of waterways, cave commercialization and improper gating, and natural calamities as the cause for the decline that led to listing.

Although natural calamity factors such as flooding, cave-ins, freezing, and disease occasionally impact gray bats, population decline is chiefly attributed to human disturbance of bats and alteration of their habitat (Barbour and Davis 1969, Mohr 1972, Tuttle 1979, Brady et al. 1982). Human activities that resulted in major impacts to bat

colonies include cave exploration, cave commercialization, and vandalism (Brady et al. 1982). Disturbance can occur either in summer when maternity colonies use caves, or in winter when caves are used as hibernacula. Disturbances in hibernacula can causes arousals that use up energy (fat) reserves. Natural and/or human-caused changes in the microclimate of caves and mines used as hibernacula can adversely affect the species (Richter et al. 1993). Disturbance of maternity caves is most harmful from late May through mid-July when nonvolant young are on the roosts; thousands may die from a single disturbance (Brady et al. 1982). Gray bats may also abandon summer caves as a result of human intrusion (Barbour and Davis 1969).

Important impacts caused by humans also include environmental alterations, including deforestation, chemical contamination, and impoundment of waterways. Deforestation may decrease prey availability; Brack and Laval (2006) found that adults, and especially juveniles, foraged in woodlands where they consume terrestrial-based prey. Thus, habitat for the species should include both aquatic and wooded, especially riparian, habitats. Frequent use of caves near rivers has made the gray bat particularly vulnerable to inundation by man-made impoundments. Impoundments may also have secondary impacts by changing the aquatic prey base and by increasing human recreational use of caves and foraging habitat.

Chemical contamination is implicated in the decline of most North American bats (USFWS 2007). Because aquatic insects are an important part of the diet, of gray bats, pollutants that enter the aquatic environment may have a large impact. Exposure is dermal (through the skin), by inhalation, or ingestion (Schmidt et al. 2001).

In the late 1970s and early 1980s, bat mortality caused by organochlorine pesticides – neurotoxins such as DDT and its break-down products (dieldrin, heptachlor epoxide) -- was documented in Missouri (Clark et al. 1978) and Texas caves. Geluso et al. (1976) and Clark et al. (1978) documented mortality in gray bats and probable population declines resulting from routine insecticide use. Organochlorine pesticides are fat soluble and thus are stored in body fats. Lethal concentrations of dieldrin were found in the brains of dead juvenile gray bats (Clark et al. 1978) and mortality of the bats was tied directly to insecticide residues acquired through insect prey. Mortality occurred about the time the young began to fly and hunt on their own, but were still dependent on their mothers' milk. The adult females, in response to the need for heavy milk production, mobilized stored fats, and the fat-soluble toxins stored in those fats.

Despite the 1972 ban of DDT in the U.S., organochlorine pesticides, which are very stable compounds and thus remain in the environment for long periods, are still found in gray bats and other bats today.

With restrictions on the use of organochlorine pesticides in the 1970s, organophosphates (OPC) and carbamates have become the most widely used pesticides in the world. They act primarily by inhibiting an enzyme essential for nerve function within the peripheral and central nervous system and they are essentially the same ingredients in tabun, sarin, soman, and cyclosarin, the most toxic chemical

warfare agents known. Toxicity induces a diverse array of abnormal behaviors such as tremors and eventual paralysis. Chronic, sub-lethal exposure adversely affects thermoregulation, food consumption, and reproduction. Gray bats and other bats suffering sublethal exposure may be unable to fly, catch prey, avoid predation or even obstacles while in flight, keep warm, care for young, or complete other tasks requisite for survival. With acute exposure, death occurs from respiratory failure. A study in Indiana indicated that chlorpyrifos is nearly ubiquitous in the carcasses and guano of bats (Eidels et al. 2006), although this was a small sample that contained no gray bats.

On 29 May 2012, the USFWS officially confirmed the presence of White Nose Syndrome (WNS) in gray bats found in Hawkins and Montgomery counties, Tennessee. Since that time, gray bats with indications of exposure to WNS (presence of the fungus and wing damage) have been detected throughout the range. No large-scale die-offs have been recorded, and the species appears to have greater resistance than many sympatric species (Frick et al. 2017). The population appears to be stable or increasing even in states such as Missouri where WNS has decimated populations of other bats (Colatskie 2017). Gray bats may be an under-appreciated means of spreading WNS to new areas due to their migratory patterns, year-long use of caves, and limited susceptibility to WNS (Colatskie et al. 2018). For example, the first indications of WNS at the Ozark Plateau National Wildlife Refuge was when biologists studying spring staging behaviors of northern long-eared and tricolored bats captured hundreds of gray bats with the characteristic wing damage. The following winter, WNS infections were common among northern long-eared and tricolored bats in these same cave systems.

3.0 Northern Long-Eared Bat (*Myotis septentrionalis)*

3.1 Description

The northern long-eared bat ranges from the northern border of Florida north and west to Saskatchewan and east to Labrador. This bat is common to a variety of forest types ranging from intact to small remnants. Although primarily an eastern species, the northern long-eared bat can be found as far west as Montana, and onto the High Plains.

The northern long-eared bat weighs about 5-8 grams (0.17-0.28 oz) at maturity and its right forearm measures about 34-38 millimeters (1.3 – 1.5 in). The wing membrane connects to the foot at the base of the first toe. The northern long-eared bat is most easily characterized by the long ears (17 millimeters [0.7 in]), which extend past the muzzle when laid forward, as well as a long and thin tragus (9 millimeters [0.4 in]) (Whitaker and Mumford 2009). The northern long-eared bats' pelage is typically colored a light to dark brown on the dorsal side and a light brown on the ventral side

(Caceres and Barclay 2000, Whitaker and Mumford 2009). Ears and wing membranes are usually a dark brown.

3.2 Status

On 2 October 2013, the northern long-eared bat was proposed for listing by USFWS as endangered. On 16 January 2015, USFWS proposed listing the northern long-eared bat as threatened with a special rule under section 4(d) of the Endangered Species Act (ESA). On 2 April 2015, USFWS published notice in the Federal Register of its final decision to list the species as threatened and issued an interim 4(d) rule exempting certain activities from the ESA's take prohibition. The listing decision and interim 4(d) rule took effect 4 May 2015. A final 4(d) rule was announced on 14 January 2016 and took effect on 16 February 2016. On 27 April 2016, USFWS determined that designation of critical habitat was not prudent. Based on hibernacula studies, the northern long-eared bat suffered estimated losses of up to 99 percent in certain areas of the northeastern U.S. since 2005, leading to its status under the ESA as threatened (USFWS 2013). USFW is currently reviewing the species to determine if a change in federal status to endangered is warranted and expects to issue a final report on that decision by summer 2021 (USFWS 2020). The species is considered endangered in Indiana (IDNR 2020).

3.3 Regional Species Occurrence

The northern long-eared bat is known to hibernate in 69 caves and mines in Indiana (USFWS 2016), most within the south-central region of Indiana (Whitaker et al. 2007). In summer, the species occurs throughout the state, with the majority in forested regions of southern Indiana (Whitaker et al. 2007). In January 2016, USFWS estimated that the northern long-eared bat population in Indiana consisted of approximately 127,842 individuals (USFWS 2016). Since WNS was documented in Indiana in early 2011, the number of northern long-eared bats detected decreased from 9 bats to 2 a 78 percent decline at the 11 major Indiana bat hibernacula (D. Brack, Personal Communication). Northern long-eared bats are difficult to detect in hibernation, but summer captures have also greatly decreased indicating the species has suffered an extreme decline.

Prior to arrival of WNS, northern long-eared bats were the most frequently captured bat on the HNF (Brack et al. 2004) and both the Yellowwood and Morgan Monroe State Forests (Sheets et al. 2013). Captures of northern long-eared bats in this region are now greatly reduced.

3.4 Seasonal Ecology

The northern long-eared bat is a "tree bat" in summer and a "cave bat" in winter. During the summer, the species is forest dependent. As with the Indiana bat, there are four ecologically distinct components of the annual life cycle: winter hibernation, spring staging and autumn swarming, spring and autumn migration, and the summer season of reproduction (Figure 4).

.

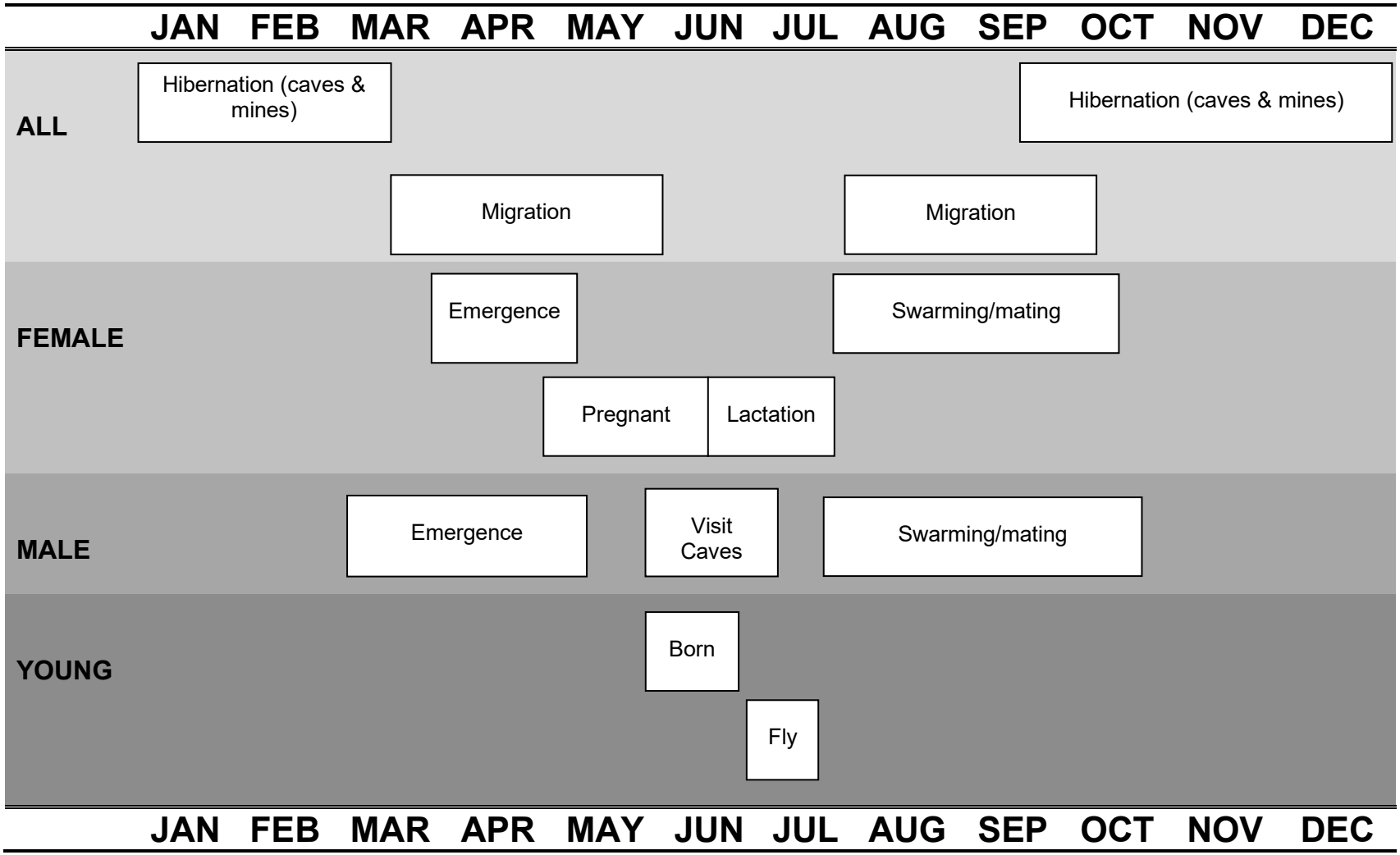
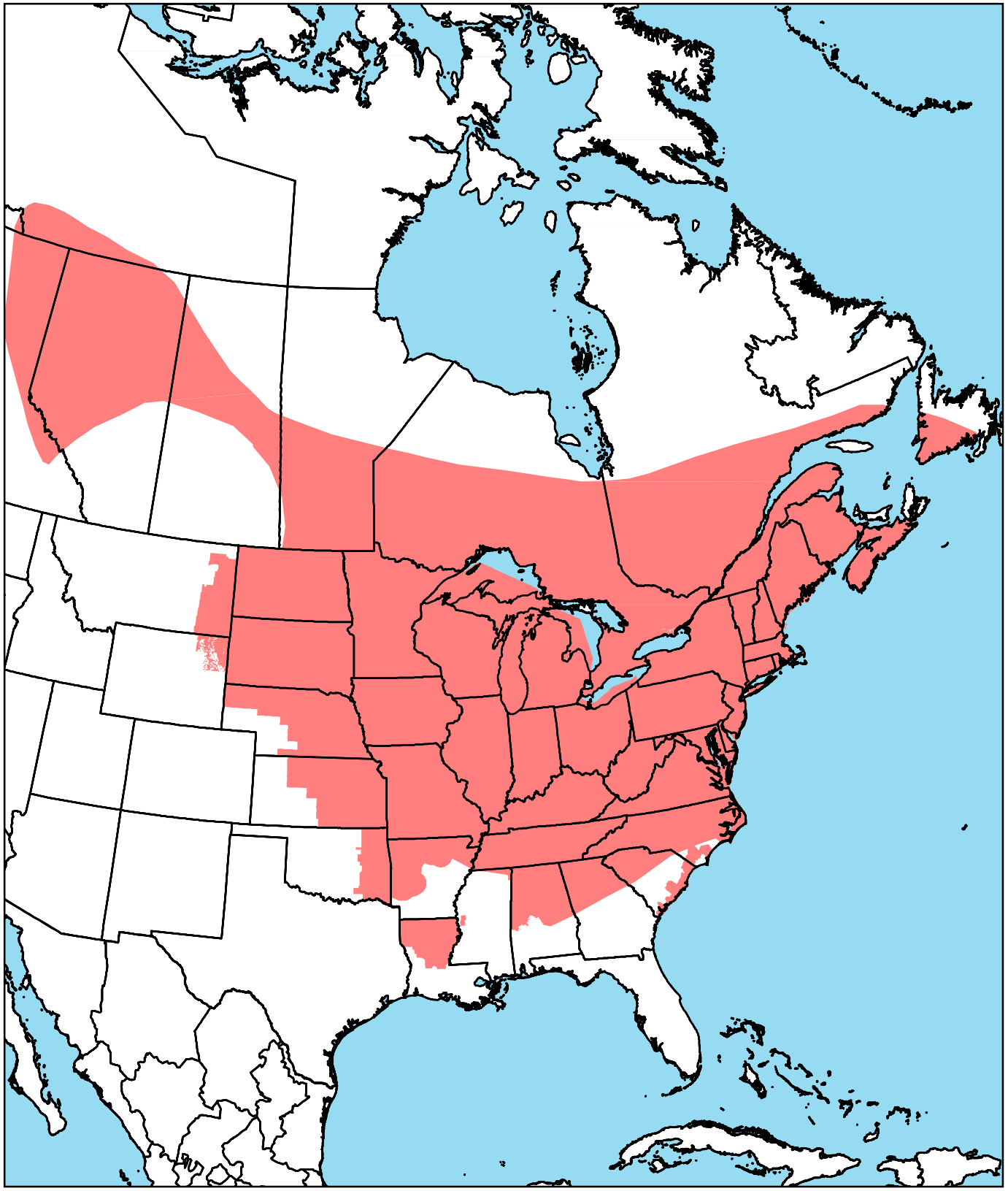


Figure 4. Seasonal chronology of northern long-eared bat activities



N
W E
S

Figure 5. Rangewide distribution of the northern long-eared bat during summer.

Project No. 1562

0 360 720 Miles

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Document Path: G:\Current\1562_Houston_South_HNF\Maps\Bat_Survey\Report_Figures\RangeMaps\Figure5_NLEB_Species_Range_Map.mxd

3.5 Summer Roosting Ecology

The summer range of the northern long-eared bat is large and includes much of the eastern deciduous forestlands from the northern border of Florida north and west to Saskatchewan and east to Labrador (Caceres and Barclay 2000, Whitaker and Mumford 2009) (Figure 5). Distribution throughout the range is not uniform, and summer occurrences are more common in the northern and northeastern portions of the species' range than in southern and western portions (Caceres and Barclay 2000, Amelon and Burhans 2006). Historically, these areas were primarily forested. Through the southern portions of their range, they appear to be less abundant, and are thought of as rare in Alabama, South Carolina, and Georgia (Mumford and Cope 1964, Barbour and Davis 1969, Amelon and Burhans 2006, Whitaker and Mumford 2009, Timpone et al. 2010). Although occasionally captured/recorded in western portions of their range, they are uncommon when records are compared to eastern areas, and may now occupy this area as a result of range expansion following settlement (Sparks et al. 2011).

When female northern long-eared bats emerge from hibernation, they migrate to maternity colonies. The distance traveled from winter hibernacula to summer roosting areas is not known. Maternity colonies are typically found in hollow trees and under bark although they also use bat-houses, buildings, and other anthropogenic structures (Amelon and Burhans 2006). After parturition, pups usually achieve volancy by 21 days (Kunz 1971, Krochmal and Sparks 2007). As the offspring become volant, average number of bats using a maternity roost declines (Lacki and Schwierjohann 2001, Sparks 2003).

A wide variety of deciduous tree species, as well as occasional coniferous species, are used as nursery colonies indicating that it is tree form, not species that is important for roosts (Caceres and Barclay 2000, Carter and Feldhamer 2005). This species regularly uses both live and dead trees (Sasse and Pekins 1996, Foster and Kurta 1999, Lacki and Schwierjohann 2001, Sparks 2003, Timpone 2004, Whitaker et al. 2004, Carter and Feldhamer 2005, Ford et al. 2006, Timpone et al. 2010, Johnson et al. 2012, Silvis et al. 2012, Johnson et al. 2013, Silvis et al. 2014). The northern long-eared bat may choose either tree condition, depending on the presence or availability within an area or possibly due to competition with or predation from other wildlife (Perry and Thill 2007a, Perry et al. 2007). Roost trees may be habitable for one to several years, depending on the species and condition of the tree. The species may also use several other structures as summer roost sites. These can be natural or man-made (e.g., bridges, barns/homes, rocky cracks or crevices). Northern long-eared bats make extensive use of bat-houses when these structures are available (Whitaker et al. 2006).

Some males and non-reproductive females remain near their winter hibernacula throughout summer while others migrate varying distances. This may be due to a preference for cooler environments in the absence of pups (Barbour and Davis 1969, Amelon and Burhans 2006).

Males can be caught at hibernacula on most nights during summer, although there may be a large turnover of individuals between nights.

Structurally, summer roosts used by males are similar to those used by maternity colonies. Trees used by males of the species are often smaller than those used by maternity colonies, perhaps because males are often solitary or form small groups and thus need less space or they may have different thermal requirements than females.

4.0 Tricolored Bat (*Perimyotis subflavus*)

4.1 Description


Credit: J. VanDeventer

The tricolored bat is a small bat in the monotypic genus *Perimyotis.* It weighs between four and eight grams (0.14 and 0.28 oz), has a forearm length between 3.2 and 3.6 centimeters (1.3 and 1.4 in) (Kurta 2008) and has a total length of 7-8 centimeters (2.8-3.1 in). Its wingspan is 21-26 centimeters (8.3-10.2 in) (Kurta 1995, Kurta 2008, WDNR 2013). Adhering to its common name, the bat's guard hairs have a tricolored appearance—dark at the base, yellow in the middle and dark at the top (Kurta 2008, WDNR 2013). Overall, the tricolored bat appears golden to reddish brown (Kurta 2008, WDNR 2013). It can be physically distinguished from similar species such as the little brown bat (*Myotis lucifugus)*, Indiana bat (*Myotis sodalis*), and northern long-eared bat (*Myotis septentrionalis*) by its smaller size, red forearms, tricolored fur, heart-shaped face, half-furred tail membrane and brown colored ears (Kurta 2008, WDNR 2013). When seen hanging from a cave wall, it is distinguished by the red 'racing stripe' forearm, hunchback appearance, and the water droplets that often form on its fur.

Most literature available for the tricolored bat is associated with an earlier name, eastern pipistrelle (*Pipistrellus subflavus).* Until 2006, *Pipistrellus* was considered an Old World genus that also contained two North American species—the eastern and western (*Pipistrellus hesperus*) pipistrelles. However, morphological data led several authors (Hamilton 1949, Menu 1984) to hypothesize that the genus *Pipistrellus* contained several evolutionary lines. Modern molecular analysis clearly indicates that neither the eastern nor the western pipistrelle were closely related to the Old World Pipistrelles nor to each other (Hoofer and Van Den Bussche 2003). Hoofer et al (2006) then placed the tricolored bat in the monotypic genus *Perimyotis*, and subsequent authors began to refer to *Perimyotis subflavus* as the tricolored bat. Some continue to use the name eastern pipistrelle for this bat in order to 1) provide nomenclatural stability and 2) avoid confusion with another bat known as the tricolored bat (*Glyphonycteris sylvestris*) (Whitaker et al. 2011). The common name may also be presented as tri-colored bat.

4.2 Status

The tricolored bat (*Perimyotis subflavus*) is not federally listed, but is a species of concern or listed at the state level throughout various states within the species' range. The species is considered endangered in Indiana (IDNR 2020). A petition to list tricolored bat as federally threatened or endangered was submitted to the USFWS 14 June 2016 (Center for Biological Diversity and Defenders of Wildlife 2016). On 20 December 2017, the USFWS indicated data provided were sufficient to initiate a formal status review (USFWS 2017). USFW is currently reviewing the species to determine if federal listing is warranted and expects to issue a final report on that decision by summer 2021 (USFWS 2020).

4.3 Regional Species Occurrence

The tricolored bat ranges from the Yucatan Peninsula to Nova Scotia, New Brunswick (Broders et al. 2001), and Quebec, and east to the Atlantic Ocean. In recent years, the species expanded its range across the High Plains (Damm and Geluso 2008) and was subsequently captured in the Intermountain West including Texas and New Mexico (Sparks and Choate 2000, Geluso et al. 2005, White et al. 2006, Valdez et al. 2009). Rapid declines associated with WNS have negatively affected the hibernating populations throughout the species' range.

Prior to arrival of WNS, tricolored bats were a frequently captured bat on the HNF (Brack et al. 2004) and both the Yellowwood and Morgan Monroe State Forests (Sheets et al. 2013). Since 2011, the population of tricolored bats has declined by 96 percent at eleven hibernacula where Indiana bats are consistently counted (D. Brack, personal communication).

4.4 Seasonal Ecology

The tricolored bat is a "tree bat" in summer and a "cave bat" in winter. There are four ecologically distinct components of the annual life cycle: winter hibernation, spring staging and autumn swarming, spring and autumn migration, and the summer season of reproduction. Figure 6 provides an annual chronology of seasonal activities.

4.4.1 Summer Roosting Ecology

The tricolored bat ranges from the Yucatan Peninsula to Nova Scotia, New Brunswick (Broders et al. 2001), and Quebec, and east to the Atlantic Ocean (Figure 7). In recent years, the species expanded its range across the High Plains (Damm and Geluso 2008) and subsequently has been captured in the Intermountain West including Texas and New Mexico (Sparks and Choate 2000, Geluso et al. 2005, White et al. 2006, Valdez et al. 2009). Rapid declines associated with WNS have decimated many populations of this species.

Tricolored bats roost in trees in summer, but unlike bats in the genus *Myotis*, they do not use cracks and crevices. In the Midwest portion of their range, tricolored bats roost primarily in clusters of dead leaves hanging from the branches of trees. In Nova Scotia, they have been recorded roosting in lichen (*Usnea trichodea*)

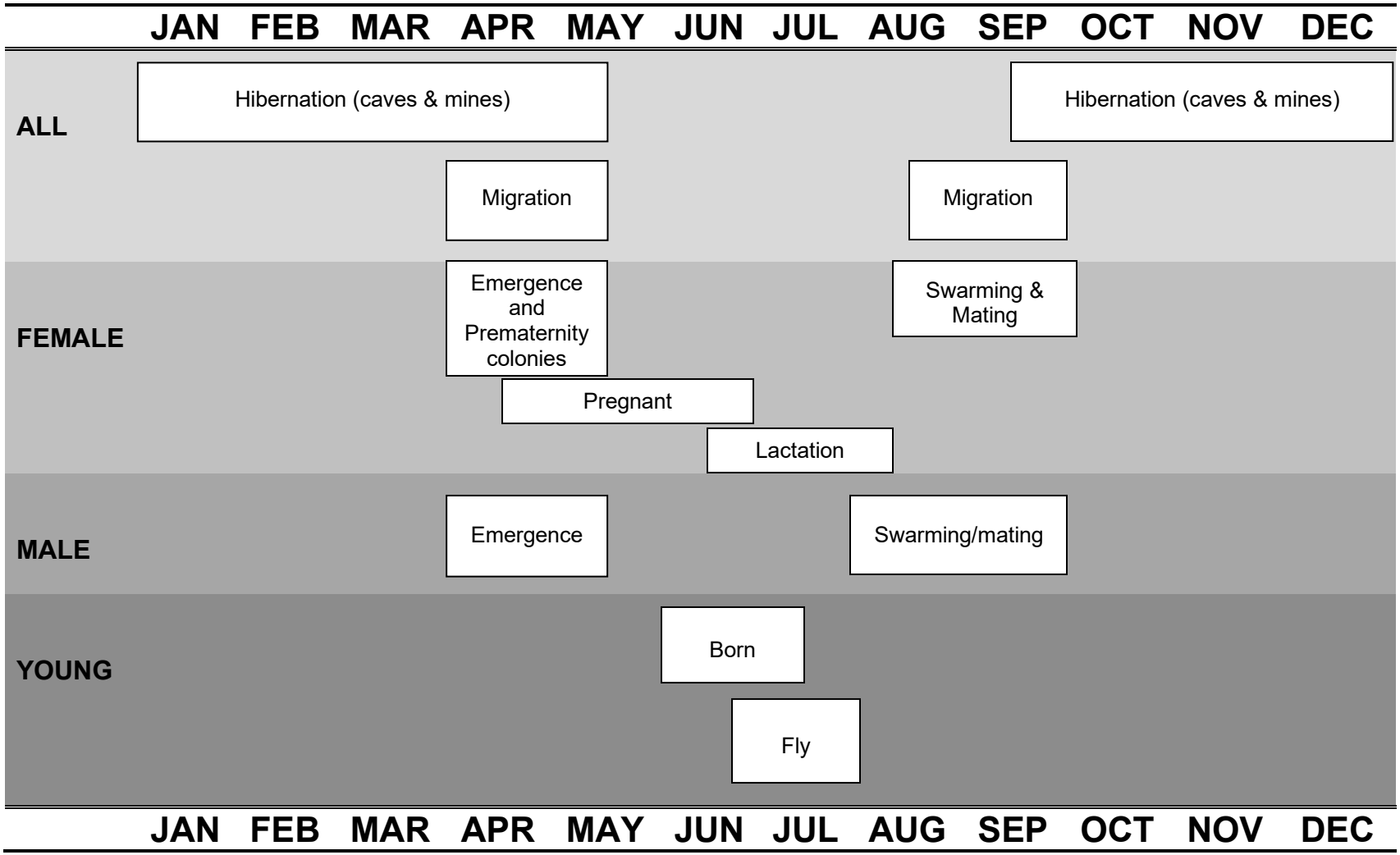


Figure 6. Seasonal chronology of tricolored bat activities.

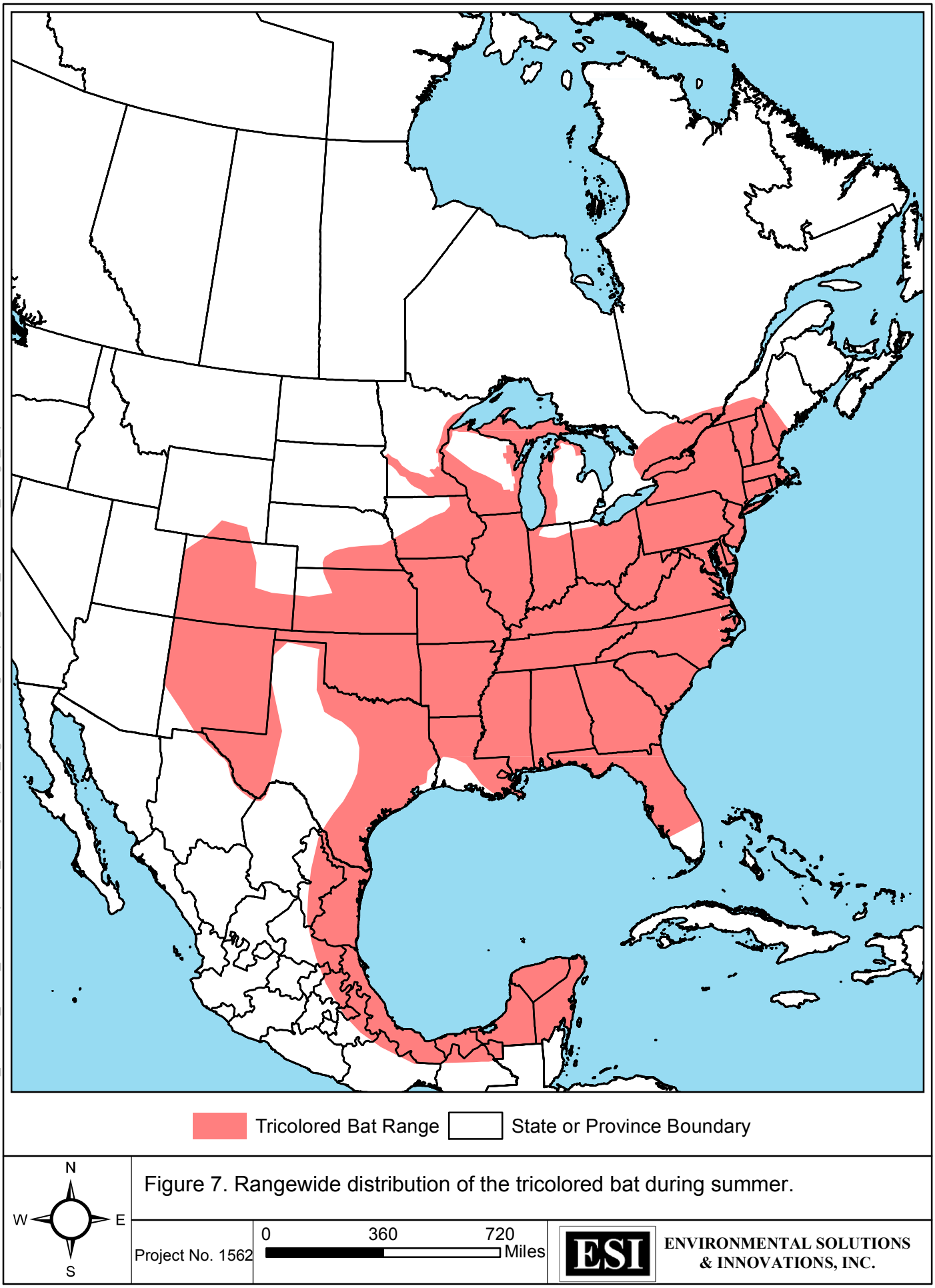


Figure 7. Rangewide distribution of the tricolored bat during summer.

Project No. 1562

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

(Veilleux et al. 2003, Perry and Thill 2007b, Poissant et al. 2010). In the southern portions of their range (Louisiana, Arkansas, and Florida), they have used Spanish moss (*Tillandsia usneoides*) (Davis and Mumford 1962), and clusters of dead pine needles accumulated in tree splits (Perry and Thill 2007b). In more northern climates, the curls of bark on paper birch (*Betula papyrifera*) may be an important roost type (WIDNR 2017) . A gray squirrel (*Sciurus carolensis*) nest was documented as a roost (Veilleux et al. 2003). Tricolored bats are not known to return to the same tree, but do return to the same area each summer, because leaf clusters decay and do not often last more than a single maternity season (Veilleux and Veilleux 2004b; a). Tricolored bats prefer wooded habitats near water (Whitaker and Mumford 2009). Helms (2010) documented the species using woodlots between five and 50 hectares (12.3 and 123.5 ac) in size.

4.4.1.1 Males

Males typically roost alone in the same type of leaf clusters and species of trees as females. However, they may exhibit higher fidelity to certain leaf clusters. A single individual in Arkansas roosted in the same cluster for 33 days (Perry and Thill 2007b). Tree size and height do not appear to impact roosting location for males, and they roost at lower heights than females (often less than five meters [16.4 ft] from the ground) (Perry and Thill 2007b). Ideal forest structure for males consists of higher densities of mid-story hardwoods like northern red oaks (Perry and Thill 2007b). As with other species of bats, some male tricolored bats remain at the hibernacula year round (Whitaker and Rissler 1992).

4.4.1.2 Females and Maternity Colonies

Prior to forming maternity colonies, tricolored bat females often form pre-maternity colonies in or on buildings in the spring. They exhibit a long staging period following emergence from hibernation (Whitaker et al. 2014), and these pre-maternity colonies may function as a permanent gathering place prior to the maternity season (Whitaker et al. 2014). The pre-maternity colonies split up into smaller groups as the season progresses, but the individuals continue to associate. Whitaker (2014) also theorized that splitting from pre-maternity colonies into smaller leaf-cluster maternity colonies may be a means of avoiding predation or seeking a site with more optimal temperature and humidity.

Maternity colonies are formed primarily within dead leaf clusters, but can also form in live leaf foliage, buildings, caves, and rock crevices (Humphrey 1975, Veilleux et al. 2003, Veilleux and Veilleux 2004a; b, Veilleux et al. 2004, Perry and Thill 2007b). These dead leaf clusters most often occur at the terminal end of live trees and form an umbrella shape. Oak (genus *Quercus*) trees and to a lesser extent maple (*Acer*) are important roosting species for tricolored bats because of their general structure, with terminal branches ending in many leaflets (Veilleux et al. 2003; 2004, Perry and Thill 2007b), although some use pines (Perry and Thill 2007b). Females generally roost in taller and larger diameter trees than males (Perry and Thill 2007b). Tricolored bat

females have been shown to switch roosts frequently, in one study approximately every 4 days (± 2.5 days) (Veilleux et al. 2003). Roosts range between 19 and 139 meters (62.3 and 456.0 ft) apart (Veilleux et al. 2003, Veilleux and Veilleux 2004b). Female tricolored bats roosted more often in upland riparian habitats rather than bottomland (Veilleux et al. 2003). Tricolored bats vary their roost position in the canopy and landscape based on reproductive condition. Reproductive female bats roost lower in the canopy and farther from forest edges that non-reproductive females. This behavior may counteract the exposed position they take in leaf clusters. Lower position in the canopy and distance from forest edge may reduce wind exposure and allow temperatures to be more stable (Veilleux et al. 2004).

Those bats roosting in leaf foliage follow a later ecological calendar compared to those bats roosting in buildings (Figure 6). Parturition in tricolored bats in foliage has been shown to be in late June in Indiana (Veilleux and Veilleux 2004a). Maternity colonies in buildings in Indiana begin forming mid-April to mid-May. Parturition in those buildings may occur at any time over a broader period, and can range from the end of May until mid-July. Roost sizes in buildings have been recorded from 7-29 individuals (Whitaker 1998), and roost sizes in trees are much smaller with a range between 1 and 13 individuals (Veilleux et al. 2003, Veilleux and Veilleux 2004a, Perry and Thill 2007b). The largest recorded summer colony size is 55 bats (Hoying and Kunz 1998).

Females typically give birth to twins after a gestation of approximately 44 days (Wimsatt 1945). The combined mass of the twins is approximately 44-54 percent of the size of the mother, a higher ratio than most Vespertilionidae bats (Kurta and Kunz 1987). Young are volant at 3 weeks and act as adults around 4 weeks old (Hoying and Kunz 1998). Post-natal growth rates slow during cold snaps because mothers cannot eat, and available energy is used for thermoregulation (Hoying and Kunz 1998). In building colonies, the adults leave as their young are weened (Whitaker 1998).

4.4.2 Food Habits and Foraging Ecology

Tricolored bats have been labeled as a clutter-adapted species, with activity levels higher in sites with greater vertical structure (Menzel et al. 2005). Tricolored bats (especially pregnant females) have a low wing aspect ratio, which makes them highly maneuverable, but also less energy efficient as fliers (Norberg and Rayner 1987). Maximal foraging distance in one study was 4.3 kilometers (2.7 mi) (Veilleux et al. 2003), and in another 3.05 kilometers (1.89 mi) with an average of 1.6 kilometers (1.0 mi) (Helms 2010). Helms (2010) also estimated an average home range size of 323 hectares (573 ac), ranging between 67 and 613 hectares (165.6 and 1514.8 ac). Activity areas include woods and wooded clearings, over streams, over farmland, and within more urban land types (Davis and Mumford 1962, Helms 2010). Preferred foraging habitats include forest, old field, grasslands, and agriculture; however, transportation corridors, low density residential, high density residential, commercial, industrial and water are also used (Helms 2010).

Diet of tricolored bats consist of Heteroptera (true bugs), Diptera (true flies), and Lepidoptera (moths), which they catch in mid-air while flying (Brack and Whitaker 2004, Whitaker 2004, Caylor 2011).

4.4.3 Winter Hibernacula

Hibernation for tricolored bats begins in the middle of September. In winter, this bat occupies a wide variety of stable hibernation sites in caves, mines, storm sewers, and even box culverts. Tricolored bats roost singly and avoid the ceiling (Brack 1979, Kurta 2008). This single roosting behavior, rather than clustering, may explain their need for warmer hibernacula environments. Tricolored bats must hibernate in a stable non-fluctuating temperature, and on average hibernate between 7.2 and 11.1 degrees Celsius (45 and 52° F), with a lower range around 1.9 degrees Celsius (35.4° F) (Brack 1979). These temperatures are generally the warmest available (Brack 1979, Brack 2007, Kurta 2008). They are an obligate hibernator, known to hibernate in subtropical regions that do not experience severe winters (McNab 1974). Hibernation may end any time from April through mid-May. (Whitaker and Rissler 1992).

4.5 Reasons for Decline

The single greatest threat facing the tricolored bat is WNS. In USFWS Service Region 5, the tricolored bat population declined 75 percent from 1999 to 2011 (Turner et al. 2011), in Ohio 98 percent, and in Indiana at least 45 percent (The Center for Biological Diversity and Defenders of Wildlife 2016). Between 2011 and 2019 the number of tricolored bats counted in eleven major Indiana bat hibernacula in Indiana declined by 96 percent.

Other potential threats include mortality at wind turbines, poisoning from pesticides and contaminants, and habitat destruction and degradation from deforestation. From 2000 to 2011, researchers estimate between 45,200 and 93,700 tricolored bats were killed at wind farms in the U.S. and Canada (Arnett and Baerwald 2013).

5.0 Little Brown Bat (*Myotis lucifugus*)

5.1 Description

The little brown bat is a small, migratory, insectivorous bat with variable fur coloration ranging from pale to dark brown, often described as “dark sooty brown through paler golden” dorsally and “pallid, to yellowish or olive brown” ventrally (Fenton and Barclay 1980, Kunz and Reichard 2010). The bat’s length is 40.64 to 55.88 millimeters

(1.6 to 2.2 in), while the ear is 10.16 to 15.24 millimeters (0.4 to 0.6 in), and the forearm is 33.02 to 40.64 millimeters (1.3 to 1.6 in) (Hall 1981). Typical body weight is 5.67 to 8.50 grams (0.2 to 0.3 oz). The little brown bat differs from the closely related Indiana bat by having a larger foot, more prominent toe hairs, and generally an unkeeled, or slightly keeled calcar.

5.2 Seasonal Ecology

The Little brown bat roosts in anthropogenic structures and trees in summer and hibernates in caves, mines, and rock crevices in winter. There are four ecologically distinct components of the annual life cycle: winter hibernation, spring staging and autumn swarming, spring and autumn migration, and the summer season of reproduction. Figure 8 provides an annual chronology of seasonal activities, and Figure 9 illustrates the species range.

5.2.1 Winter Habitat

Little brown bats' winter habitat consists primarily of caves and mines that serve as hibernacula. Like other Myotis, little brown bat shows high philopatry for a hibernaculum. Suitable hibernacula have high humidity and relatively stable, cool temperatures (Fenton 1970, Humphrey and Cope 1976). Individual little brown bats are found hibernating across a wide range of temperatures, from freezing up to 13° or 14° Celsius (55.4° or 57.2° F). In Missouri, Brack (1979) found 22.4 percent of 1,488 occurrences of hibernating little brown bat were at 9˚ Celsius (48.2° F), but at least 3 percent of all occurrences were at each whole degree Celsius temperature from 4° to 12˚ Celsius (39.2° to 53.6° F). In Ohio, during four winter surveys between 1996 and 2002, a mean of 19,419 bats (± 4,961) were observed hibernating at a mean temperature of 7.2˚ (± 2.6˚) Celsius (45° F) (Brack 2007). In Virginia, the largest concentration of little brown bats (N = 4,280) hibernated in an area that was 6.5˚ Celsius (43.7° F), although the species was recorded at 1˚ to 14˚ Celsius (33.8° to 57.2° F) (Brack et al. 2005). The timing of the onset of hibernation varies latitudinally and altitudinally across the range due to differences in temperature and the length of the season of hibernation (Humphries et al. 2002). Little brown bats may hibernate individually, in small clusters, or clusters that contain thousands of individuals. Unlike the Indiana bat, hibernating in tightly packed clusters, the clusters of the little brown are often loose and irregular. Site fidelity is high, with most individuals returning to the same site to swarm, mate, and hibernate (Davis and Hitchcock 1965, Humphrey and Cope 1976).

Upon entering hibernation, body temperatures drop close to ambient cave temperatures while the bat is torpid (Geiser 2004a; b). At this low body temperature, metabolic rates slow to 5 to 30 percent of basal metabolic rates, conserving critical energy stored as fat (Thomas et al. 1990, Geiser 2004a; b). During hibernation,

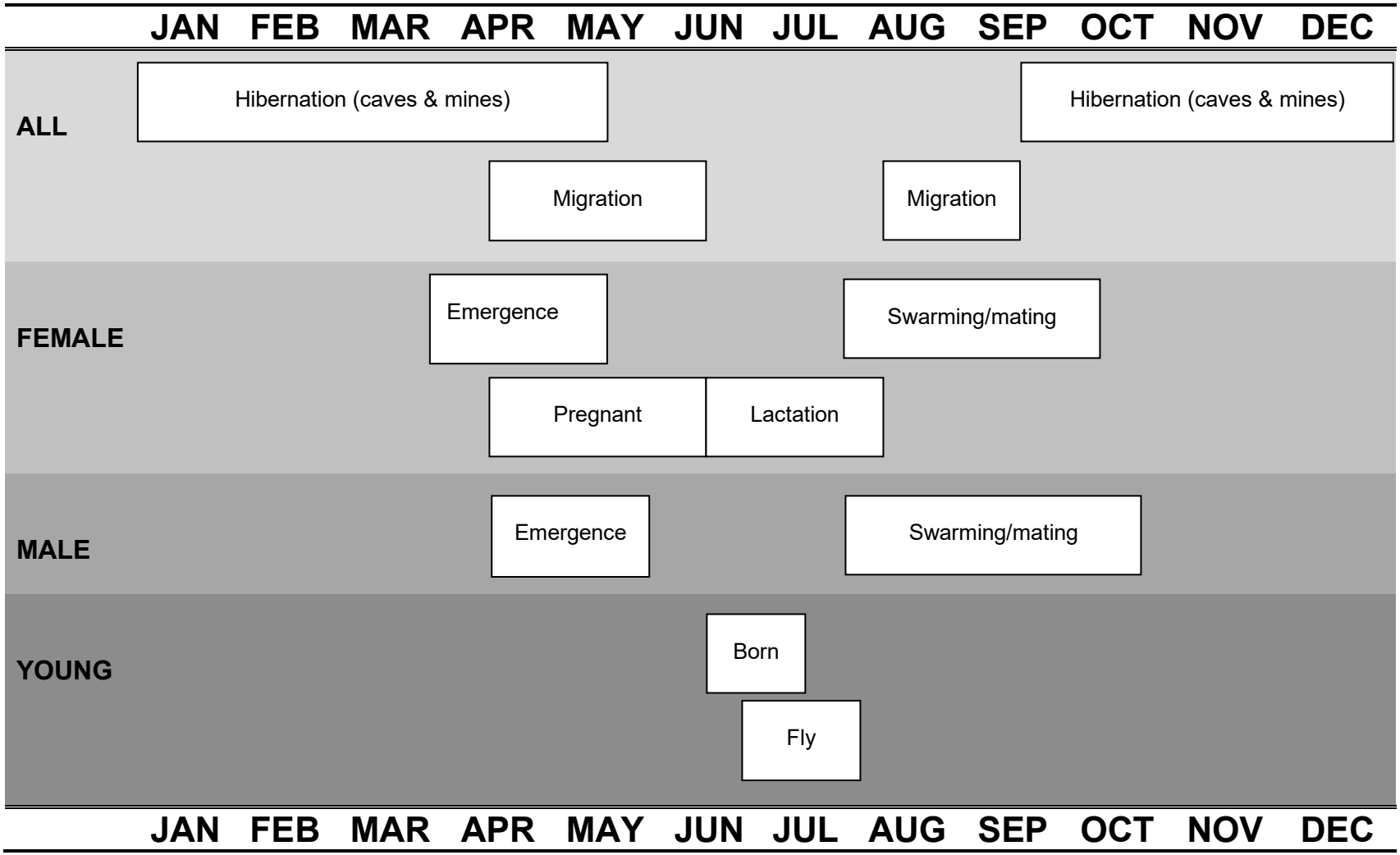


Figure 8. Seasonal chronology of little brown bat activities.

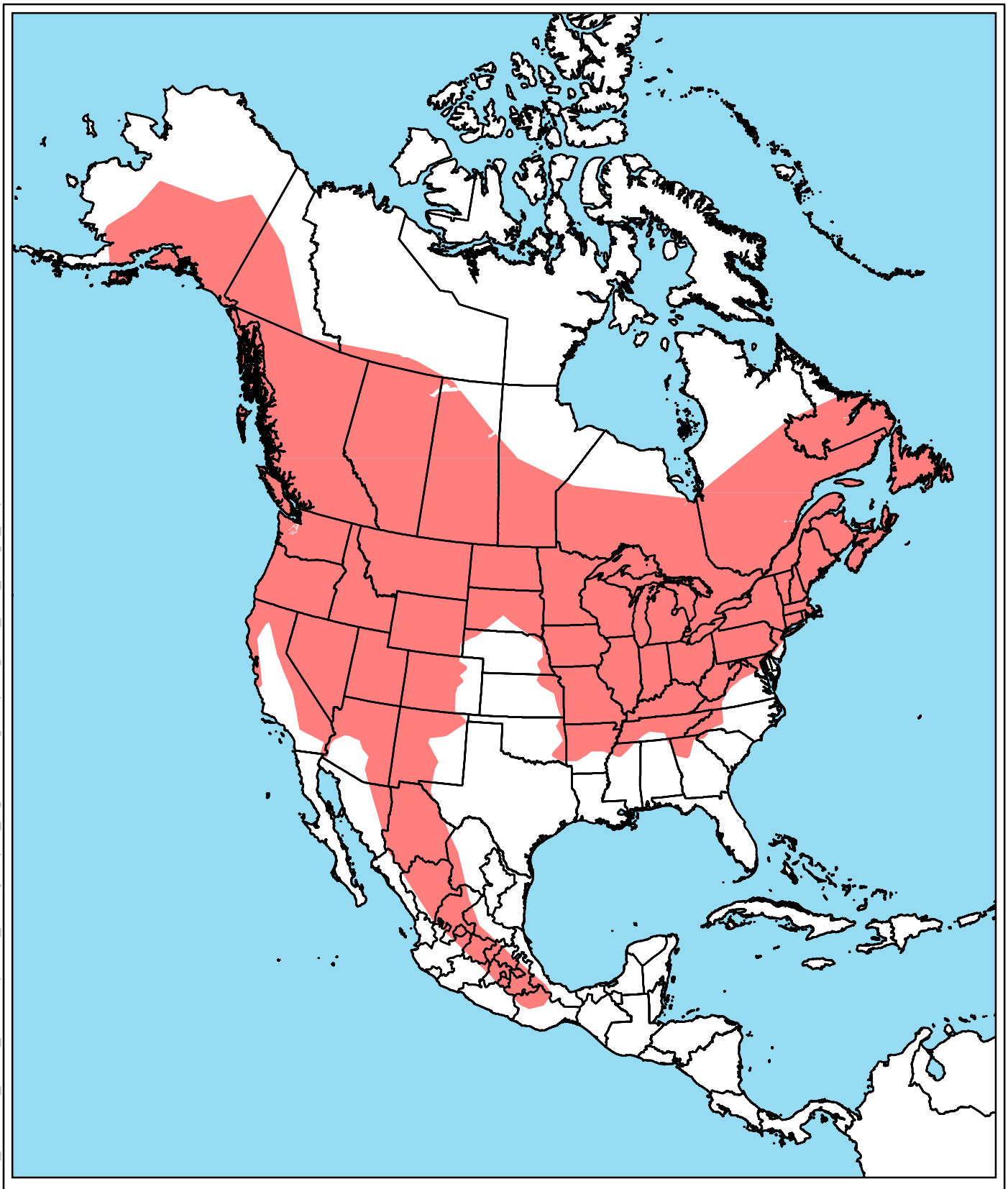


Figure 9. Rangewide distribution of the little brown bat during summer.

Project No. 1562

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

individual bats periodically arouse for reasons that are not entirely understood (Thomas et al. 1990, Geiser 2004a; b), but arousal may function to excrete metabolic waste, sleep, drink, repair damage to the myelin of nerves, or a variety of other functions (Thomas and Geiser 1997). Little brown bats arouse from torpor every 12 to 20 days (Brack and Twente 1985, Twente et al. 1985). Although arousal accounts for less than 1 percent of a period (or bout) of hibernation, it can account for 80 to 95 percent of the energy expenditure (Thomas et al. 1990, Dunbar and Tomasi 2006, Boyles and Brack 2009). Arousals later in spring when some bats have nearly exhausted their energy reserves may reduce survival rates (Boyles and Brack 2009) or burden females with an additional energy requirement in spring, immediately after the season of hibernation (Kunz et al. 1998).

Once infected with WNS bats undergo a series of physiological and behavioral changes that eventually prove fatal unless the bats emerge from hibernation and become active (Verant et al. 2014). Infected bats arouse more often than uninfected bats and the frequency of arousal increases with increased severities of infection (Reeder et al. 2012, Warnecke et al. 2012). Infected bats spend more energy even when not fully aroused and suffer both dehydration and electrolyte depletion (Cryan et al. 2013, Verant et al. 2014). During arousals, infected bats are less active than healthy bats, spend a similar amount of time drinking (despite their dehydration) and spend less time grooming (Bohn et al. 2016). Infected bats have higher skin temperatures (i.e., fevers) than uninfected bats (Mayberry et al. 2018).

Habitat selection within the hibernacula also changes with infected bats moving to colder areas (often near the entrance, and less thermally stable)—a change hypothesized to minimize arousals (Reeder et al. 2010, Johnson et al. 2016) and lead to slower fungal growth (Verant et al. 2012). Infected bats are less likely found in clusters, potentially reducing the spreading fungus to conspecifics including relatives, reducing chances of becoming cross-infected, and minimizing disturbance caused when neighboring bats arouse (Wilcox et al. 2014, Turner et al. 2015). At the end of the disease process, sick bats may also leave the hibernacula and be found out on the landscape prior to normal spring emergence (Wilcox et al. 2014, Heffernan and Turner 2016).

5.2.2 Summer Habitat

Reproductive females begin forming maternity colonies in late April and early May, often in human-made structures, but also under tree bark, in rock crevices, and in tree hollows (Humphrey and Cope 1976, Fenton and Barclay 1980). Colonies usually number 300 to 1,200 bats (adults and offspring), but can reach up to 3,000 (Humphrey and Cope 1976). Reproductive females prefer hot, humid roosts ranging from 23.3° to 34.4° Celsius (73.9° to 93.9° F) (Burnett and August 1981), as much as 8° to 10° Celsius (46.4° to 50° F) above ambient temperature (Brittingham and Williams 2000). For natural roosts, both sexes prefer old-growth and mature trees that provide crevices and cavities (Fenton and Barclay 1980, Crampton and Barclay 1998) at sites close to water, because of a preference to forage over open water, near shorelines, and along

edge habitat (Fenton and Barclay 1980). Summer roost fidelity among females tends to be high, with adult females returning to their natal roosts (Frick et al. 2010b). Adult males roost in small groups, typically not with reproductive females. Males may also use caves and mines during summer. Broders et al. (2006) found that little brown bats in New Brunswick, Canada, had average roosting home ranges of 4.01 hectares (9.90 ac) and foraging areas of 52 hectares (128.50 ac). Foraging areas were an average 253.90 meters (833 ft) from roosts.

5.2.3 Spring and Fall Migration

In late summer and fall, little brown bats migrate from summer habitat, while using a variety of transient roosts (Fenton and Barclay 1980) before arriving at winter hibernacula. Average migration distance is estimated as 99.78 kilometers (62 mi), although some individuals travel 299.34 or more kilometers (186 mi) from summer roosts (Davis and Hitchcock 1965, Fenton 1970, Humphrey and Cope 1976).

5.2.4 Fall Habitat

Between July and October, depending on latitude, little brown bats return to hibernacula to swarm, thought to serve three primary purposes: 1) introduce juveniles to potential hibernacula, 2) copulation, and 3) rest at stop-over sites on migratory pathways between summer and winter regions (Parsons et al. 2003, Lowe 2012, Randall and Broders 2014) . During this time, adult little brown bats rapidly increase body mass by about 30 percent, or 2.83 grams (0.10 oz) (Kunz et al. 1998). When outside temperatures drop and insects become scarce, little brown bats enter hibernation.

Swarming, little brown bats in Canada roosted within 8.05 kilometers (5 mi) of hibernacula (Lowe 2012), but like Indiana bats it is likely little brown bats within large hibernacula travel farther afield. Available data indicate roosts are spatially clustered with regard to distance from the hibernacula (Lowe 2012) indicating bats are far more dense near the hibernacula than out on the wide landscape.

5.2.5 Females and Maternity Colonies

Most known maternity colonies are in anthropogenic structures and prior to WNS contained many bats, such as colonies of at least 700 bats in Lewis County and 2000 bats in Sullivan County, Missouri (Boyles et al. 2009). Like the Indiana bat, female little brown bats use warm roosts (Burnett and August 1981). In other areas little brown bats select roost trees that are large, dead or dying trees with substantial solar exposure (Crampton and Barclay 1998, Bergeson et al. 2015). Little brown bats make frequent use of cracks and hollows in trees as well as under sloughing bark (Crampton and Barclay 1998, Bergeson et al. 2015).

Barbour and Davis (1969) noted that females are pregnant when they arrive at maternity roosts in early- to mid-April, with individuals arriving throughout May and into June. In Indiana (Krochmal and Sparks 2007), females in one colony gave birth to a single pup between 3 June and 15 July. Pups began fluttering at 2 days of

age, could complete coordinated wing strokes by 15 days and could fly by 21 days. Thus, most pups were flying by mid-July. Maternity colonies begin to break up as soon as the young are weaned in July and few remain by September (Barbour and Davis 1969).

5.2.6 Food Habits and Foraging Ecology

In some ways, the diet of little brown bats is similar to that of the Indiana bat with most of the diet composed of six orders of insects: Lepidoptera (moths), Coleoptera (beetles), Diptera (true flies), Homoptera (bugs), Trichoptera (caddisflies), and Hymenoptera (wasps and ants) (Whitaker 1972, Belwood and Fenton 1976, LaVal and LaVal 1980, Carter et al. 2003). However, the jaws of little brown bats are smaller than Indiana bats (Brack 1983), which allow the species to exploit the exponentially more abundant small insect resources (Schoener and Janzen 1968). Small aquatic flies are an important food source (Whitaker 1972, Belwood and Fenton 1976, LaVal and LaVal 1980, Carter et al. 2003) and multiple species of mosquitos are included in the diet (Wray et al. 2018). Given this reliance on aquatic insects, it should be no surprise that the foraging habitat of little brown bats is often strongly associated with aquatic habitats including streams, lakes, ponds, and wetlands (Belwood and Fenton 1976, Buchler 1980, Broders et al. 2006, Bergeson et al. 2013). Newly volant juveniles select foraging habitats near the roost and often hunt from perches, whereas adults forage further afield (Buchler 1980). When an insect outbreak killed many trees in a forest, little brown bats at the site preferentially foraged in the open areas created by dead and fallen trees (Randall et al. 2011). This same study described preferred foraging habitats as open areas with abundant prey, that were close to town (where the bats roosted) and near water (Randall et al. 2011). Following foraging bouts, little brown bats regularly use night roosts including bridges, buildings, caves, and trees (Buchler 1980, Fenton and Barclay 1980, Barclay 1982, Keeley and Tuttle 1999)

5.3 Reasons for Decline

The single greatest threat facing the little brown bat is WNS. Other potential threats include mortality at wind turbines, poisoning from pesticides and contaminants, and habitat destruction and degradation from deforestation. From 2000 to 2011, researchers estimate between 51,617 and 106,925 little brown bats were killed at wind farms in the U.S. and Canada (Arnett and Baerwald 2013).

5.3.1 Patterns of Decline

Historically, little brown bat was one of the most common and widespread bat species in North America. Long-term monitoring of 22 hibernacula in the northeastern U.S. indicated a population of 6.5 million as of 2006, when the northeastern population was considered stable or slightly increasing (Frick et al. 2010a). However, WNS dramatically reduced little brown bat populations, most notably in the northeastern U.S. where WNS has been present for 10 or more years. Frick et al. (2010a) reported annual mortality in affected caves in the northeast of 30 to 99 percent, with a mean of 73 percent. Additional analyses completed as part of the USFWS's voluntary review process indicated winter populations at 165 monitored sites across three

USFWS regions and 16 states had declined by approximately 93 percent between 2006 and 2016 (Tinsley 2016). In addition to causing direct mortality, WNS has reduced reproductive success, with juveniles declining from 60 percent of mist net captures to 20 percent (Francl et al. 2012). It is unclear if reduced reproductive rates are caused by difficulty in finding mates, as a consequence of reduced physiological condition of females, or a loss of benefits from coloniality, all mediated by impacts of WNS. Based on this trend, the little brown bat could be extirpated in its core range by 2026 (Frick et al. 2010a, Frick et al. 2010b). Since 2011, the population of little brown bats has declined by 89 percent at eleven hibernacula in Indiana where Indiana bats are consistently counted (D. Brack, personal communication).

5.3.2 Survivorship

The arrival of WNS changed little brown bats from being one of the most abundant and longest-lived bats in North America into a species with greater large-scale annual mortality. Over time, the effects of WNS appear to be ameliorating.

5.3.2.1 Pre-WNS Survivorship

As with similar bats, little brown bats are long-lived once they reach adulthood. Juvenile mortality is high for most species of bats (Tuttle and Stevenson 1982), as reflected in relatively low (13 to 46%) survival rates among first-year bats (Humphrey and Cope 1976, Frick et al. 2010b). Conversely, prior to the arrival of WNS, adult little brown bat survival was high. Banded bats were routinely discovered surviving into their twenties with some bats recaptured 30 years after banding (Keen and Hitchcock 1980). Authors measured annual survival rates of 50 to 90 percent per year (Humphrey and Cope 1976, Keen and Hitchcock 1980, Frick et al. 2010b).

5.3.2.2 Post-WNS Survivorship

Survivorship data also exist for little brown bats post-WNS, and two available studies are based on banded bats in known maternity colonies. Maslo et al. (2015) found annual mortality rates declined from the time WNS arrived until four years later during which time annual survival rates for male and female bats improved from 0.68 to 0.75 and from 0.65 to 0.70, respectively. The study found no evidence of immigration from other maternity colonies. Even though survival rates are increasing, current survival rates predict the population will decline by five percent per year. Effectively, the authors are indicating effects of WNS ameliorate over time, but the improvement may not be enough to stabilize populations.

Dobony and Johnson (2018) examined a maternity colony at Fort Drum, New York for eleven years (2006 to 2017) including two years prior to WNS arrival at the site. Annual survival rates, post-WNS (2010 to 2015), varied widely from (0.41 to 0.87) between years and individual survival was not predicted by a variety of factors including prior infection with WNS or reproductive condition. The colony suffered an initial decline of 88 percent but subsequently stabilized and began to increase. The study also documented immigration of at least one survivor from another maternity colony.

6.0 Literature Cited

Amelon, S. and D. Burhans. 2006. Conservation assessment: *Myotis septentrionalis* (northern long-eared bat) in the Eastern United States. U.S. Department of Agriculture, Forest Service, General Technical Report NC-260: Conservation Assessments for Five Forest Bat Species in the Eastern United States.

Arnett, E. and E. F. Baerwald. 2013. Impacts of wind energy development on bats: implications for conservation. Pages 435-456. *in* Bat Evolution, Ecology, and Conservation (R.A. Adams and S.C. Pederson, eds.). Springer Science, New York.

Barbour, R. W. and W. H. Davis. 1969. Bats of America. University Press of Kentucky, Lexington, Kentucky. 312 pp.

Barclay, R. M. R. 1982. Night roosting behavior of the little brown bat, *Myotis lucifugus*. Journal of Mammalogy 63:464-474.

Belwood, J. J. and M. B. Fenton. 1976. Variation in the diet of *Myotis lucifugus* (Chiroptera: Vespertilionidae). Canadian Journal of Zoology 54:1674-1678.

Bergeson, S. M., T. C. Carter, and M. D. Whitby. 2013. Partitioning of foraging resources between sympatric Indiana and little brown bats. Journal of Mammology 94:1311-1320.

Bergeson, S. M., T. C. Carter, and M. D. Whitby. 2015. Adaptive roosting gives little brown bats an advantage over endangered Indiana bats. American Midland Naturalist 174:321–330.

Best, T. L. and M. K. Hudson. 1996. Movements of gray bats (*Myotis grisescens*) between roost sites and foraging areas. Journal of the Alabama Academy of Science 67:6-14.

Best, T. L. and B. A. Milam. 1997. Variation in diet of the gray bat (*Myotis grisescens*). Journal of Mammalogy 78:569-583.

Bohn, S. J., J. M. Turner, L. Warnecke, C. Mayo, L. P. McGuire, V. Misra, T. K. Bollinger, and C. K. R. Willis. 2016. Evidence of 'sickness behaviour' in bats with white-nose syndrome. Behavior 153:981-1003.

Boyles, J., J. Timpone, and L. W. Robbins. 2009. Bats of Missouri. Indiana State University, Center for North American Bat Research and Conservation, Publication number 3. 60 pp.

Boyles, J. G. and V. Brack, Jr. 2009. Modeling survival rates of hibernating mammals with individual-based models of energy expenditure. Journal of Mammalogy 90:9-16.

Brack, V., Jr. 1979. The duration of the period of hibernation in *Eptesicus fuscus, Myotis lucifugus*, and *Pipistrellus subflavus* under natural conditions. Unpublished M.S. thesis. University of Missouri, Columbia, Missouri.

Brack, V., Jr. 1983. The nonhibernating ecology of bats in Indiana with emphasis on the endangered Indiana bat, *Myotis sodalis*. Unpublished Ph.D. dissertation, Purdue University, West Lafayette, Indiana. 280 pp.

Brack, V., Jr. 2007. Temperatures and locations used by hibernating bats, including *Myotis sodalis* (Indiana Bat), in a limestone mine: implications for conservation and management. Environmental Management 40:739-746.

Brack, V., Jr. and R. K. LaVal. 1985. Food habits of the Indiana bat in Missouri. Journal of Mammalogy 66:308-315.

Brack, V., Jr. and R. K. Laval. 2006. Diet of the gray Myotis (*Myotis grisescens*): variability and consistency, opportunism, and selectivity. Journal of Mammalogy 87:7-18.

Brack, V., Jr., R. E. Mumford, and V. R. Holmes. 1984a. The gray bat (*Myotis grisescens*) in Indiana. American Midland Naturalist 111:205.

Brack, V., Jr., R. J. Reynolds, W. Orndorff, J. Zokaites, and C. Zokaites. 2005. Bats of Skydusky Hollow, Bland County, Virginia. Virginia Journal of Science 56:93-106.

Brack, V., Jr., C. W. Stihler, R. J. Reynolds, C. M. Butchkoski, and C. S. Hobson. 2002. Effect of climate and elevation on distribution and abundance in the mid-eastern United States. Pages 21-28 *in* The Indiana Bat: Biology and Management of an Endangered Species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas.

Brack, V., Jr. and J. W. Twente. 1985. The duration of the period of hibernation in three species of vespertilionid bats. I. Field studies. Canadian Journal of Zoology 63:2952-2954.

Brack, V., Jr. and J. O. Whitaker, Jr. 2004. Bats of the Naval Surface Warfare Center at Crane, Indiana. Proceedings of the Indiana Academy of Science 113:66-75.

Brack, V., Jr. and J. O. Whitaker, Jr. 2006. The Indiana Myotis (*Myotis sodalis*) on an anthropogenic landscape: Newport Chemical Depot, Vermillion County, Indiana. Proceedings of the Indiana Academy of Science 115:44-52.

Brack, V., Jr., J. O. Whitaker, Jr., and S. E. Pruitt. 2004. Bats of Hoosier National Forest. Proceedings of the Indiana Academy of Science 113:78-86.

Brack, V., Jr., A. M. Wilkinson, and R. E. Mumford. 1984b. Hibernacula of the endangered Indiana bat in Indiana. Proceedings of the Indiana Academy of Science 93:463-468.

Brady, J., T. Kunz, M. Tuttle, and D. Wilson. 1982. Gray bat recovery plan. U.S. Department of Interior, Fish and Wildlife Service in cooperation with the Gray Bat Recovery Team, Denver, Colorado. 143 pp.

Brittingham, M. C. and L. M. Williams. 2000. Bat boxes as alternative roosts for displaced bat maternity colonies. Wildlife Society Bulletin 28:197-207.

Britzke, E. R., M. J. Harvey, and S. C. Loeb. 2003. Indiana bat, *Myotis sodalis*, maternity roosts in the southern United States. Southeastern Naturalist 2:235-242.

Broders, H. G., G. J. Forbes, S. Woodley, and I. D. Thompson. 2006. Range extent and stand selection for roosting and foraging in forest-dwelling northern long-

eared bats and little brown bats in the Greater Fundy Ecosystem, New Brunswick. Journal of Wildlife Management 70:1174-1184.

Broders, H. G., D. F. McAlpine, and G. J. Forbes. 2001. Status of the eastern pipistrelle (*Pipistrellus subflavus)* (Chiroptera: Vespertilionidae) in New Brunswick. Northeastern Naturalist 8:331-336.

Brown, R. J. and V. Brack, Jr. 2003. An unusually productive net site over an upland road used as a travel corridor. Bat Research News 44:187-188.

Brown, R. J., R. A. King, and R. Rommé. 2001. First documented maternity colony of the Indiana bat in Greene County, Ohio (Abstract). Bat Research News 42:27.

Buchler, E. R. 1980. The development of flight, foraging, and echolocation in the little brown bat (*Myotis lucifugus*). Behavioral Ecology and Sociobiology 6:211-218.

Burnett, C. D. and P. V. August. 1981. Time and energy budgets for day roosting in a maternity colony of *Myotis lucifugus*. Journal of Mammalogy 62:758-766.

Caceres, M. C. and R. M. R. Barclay. 2000. *Myotis septentrionalis*. Mammalian Species 634:1-4.

Callahan, E. V., R. D. Drobney, and R. L. Clawson. 1997. Selection of summer roosting sites by Indiana bats (*Myotis sodalis*) in Missouri. Journal of Mammalogy 78:818-825.

Carter, T. C. 2003. Summer habitat use of roost trees by the endangered Indiana bat (*Myotis sodalis*) in the Shawnee National Forest of Southern Illinois. Ph.D. dissertation. Southern Illinois University, Carbondale, Illinois.

Carter, T. C. and G. A. Feldhamer. 2005. Roost tree use by maternity colonies of the Indiana bats and the northern long-eared bats in southern Illinois. Forest Ecology and Management 219:259-268.

Carter, T. C., M. A. Menzel, S. F. Owen, J. W. Edwards, and J. M. Menzel. 2003. Food habits of seven species of bat in the Allegheny Plateau and Ridge and Valley of West Virginia. Northeastern Naturalist 10:83-88.

Caylor, M. K. 2011. Impacts of different forest tree-harvest methods on diets and populations of insectivorous forest bats. Indiana State University, Terre Haute, Indiana.

Center for Biological Diversity and Defenders of Wildlife. 2016. Petition to list the tricolored bat *Perimyotis subflavus* as threatened or endangered under the Endangered Species Act. Petition submitted to the U.S. Secretary of the Interior, acting through the U.S. Fish and Wildlife Service. The Center for Biological Diversity, Tucson, Arizona and Defenders of Wildlife, Washington D.C. 76pp.

Cervone, T. H. and R. K. Yeager. 2016. Bats under an Indiana bridge. Proceedings of the Indiana Academy of Science 125:91-102.

Clark, D. R., Jr, R. K. LaVal, and D. M. Swineford. 1978. Dieldrin-induced mortality in an endangered species, the gray bat (*Myotis grisescens*). Science 199:1357-1359.

Clawson, R. L. and R. R. Titus. 1992. Management plan for the Indiana and gray bat in Missouri. Missouri Department of Conservation, Jefferson City, Missouri.

Colatskie, S. 2017. Missouri bat hibernacula survey results from 2011-2017, following white-nose syndrome arrival. Missouri Department of Conservation, Jefferson City, Missouri. 14 pp.

Colatskie, S. N., J. T. Layne, C. Gerdes, and L. W. Robbins. 2018. Recent migratory movements of gray bats (*Myotis grisescens*) in Missouri: Potential to spread *Pseudogymnoascus destructans*? Bat Research News 59:11-19.

Crampton, L. H. and M. R. Barclay. 1998. Selection of roosting and foraging habitat by bats in different-aged aspen mixedwood stands. Conservation Biology 12:1347-1358.

Cryan, P. M., C. U. Meteyer, D. S. Blehert, J. M. Lorch, D. M. Reeder, G. G. Turner, J. Webb, M. Behr, M. Verant, R. E. Russell, and K. T. Castle. 2013. Electrolyte depletion in White-nose Syndrome bats. Journal of Wildlife Diseases 49:398–402.

Damm, J. P. and K. Geluso. 2008. Use of a mine by eastern pipistrelles in east-central Nebraska. Western North American Naturalist 68:382-389.

Davis, W. H. and H. B. Hitchcock. 1965. Biology and migration of the bat, *Myotis lucifugus*, in New England. Journal of Mammalogy 45:475-476.

Davis, W. H. and R. E. Mumford. 1962. Ecological notes on the bat *Pipistrellus subflavus*. American Midland Naturalist 68:394-398.

Decher, J. and J. R. Choate. 1995. *Myotis grisescens*. Mammalian Species 510:1-7.

Dobony, C. A. and J. B. Johnson. 2018. Observed Resiliency of Little Brown Myotis to Long-Term White-Nose Syndrome Exposure. Journal of Fish and Wildlife Management 9:168-179.

Dunbar, M. B. and T. E. Tomasi. 2006. Arousal patterns, metabolic rate, and an energy budget of eastern red bats (*Lasiurus borealis*) in winter. Journal of Mammalogy 87:1096-1102.

Eidels, R. R., J. O. Whitaker, Jr., and D. W. Sparks. 2006. Organophosphate Insecticide residues in bats and guano from Indiana. *in* Proceedings of The American Society of Mammalogists, 85th Annual Meeting.

Evans, J. E. and N. Drilling. 1992. Element stewardship abstract for gray bat. Nature Conservancy.

Fenton, M. B. 1970. Population studies of *Myotis lucifugus*: (Chiroptera: Vespertilionidae) in Ontario. Life sciences contributions no. 77. Royal Ontario Museum, Ontario, Canada. 34 pp.

Fenton, M. B. and R. M. R. Barclay. 1980. *Myotis lucifugus*. Mammalian Species 142:1-8.

Ford, W. M., S. F. Owen, J. W. Edwards, and J. L. Rodrigue. 2006. *Robinia pseudoacacia* (Black Locust) as day-roosts of male *Myotis septentrionalis* (Northern Bats) on the Fernow Experimental Forest, West Virginia. Northeastern Naturalist 13:15-24.

Foster, R. W. and A. Kurta. 1999. Roosting ecology of the northern bat (*Myotis septentrionalis*) and comparisons with the endangered Indiana bat (*Myotis sodalis*). Journal of Mammalogy 80:659-672.

Francl, K. E., W. M. Ford, D. W. Sparks, and V. Brack, Jr. 2012. Capture and reproductive trends of summer bat communities in West Virginia: assessing the impact of white nose syndrome. Journal of Fish and Wildlife Management 3:33-42.

Frick, W. F., T. L. Cheng, K. E. Langwig, J. R. Hoyt, A. F. Janicki, K. L. Parise, J. T. Foster, and A. M. Kilpatrick. 2017. Pathogen dynamics during invasion and establishment of white-nose syndrome explain mechanisms of host persistence. Ecology 98:624-631.

Frick, W. F., J. F. Pollock, A. C. Hicks, K. E. Langwig, D. S. Reynolds, G. G. Turner, C. M. Butchkoski, and T. H. Kunz. 2010a. An emerging disease causes regional population collapse of a common north American bat species. Science 329:679-682.

Frick, W. F., D. S. Reynolds, and T. H. Kunz. 2010b. Influence of climate and reproductive timing on demography of little brown myotis *Myotis lucifugus*. Journal of Animal Ecology 79:128-136.

Gardner, J. E., J. D. Garner, and J. E. Hofmann. 1991. Summer roost selection and roosting behavior of *Myotis sodalis* (Indiana bat) in Illinois. Unpublished report. Illinois Natural History Survey, Illinois Department of Conservation, Section of Faunistic Surveys and Insect Identification. Champaign, Illinois. 56 pp.

Geiser, F. 2004a. Metabolic rate and body temperature reduction during hibernation and daily torpor. Annual Review of Physiology 66:239-274.

Geiser, F. 2004b. Metabolic rate reduction during hibernation and daily torpor. Pages 175-184 *in* Life in the Cold: Evolution, Mechanisms, Adaptation, and Application. Twelfth International Hibernation Syposium (B. M. Barnes and H. V. Carey, eds.). Biological Papers of the University of Alaska, Number 27. Fairbanks, Alaska.

Geluso, K., T. R. Mollhagen, J. M. Tigner, and M. A. Bogan. 2005. Westward expansion of the eastern pipistrelle (*Pipistrellus subflavus*) in the United States, including new records from New Mexico, South Dakota, and Texas. Western North American Naturalist 65:405-409.

Geluso, K. N., J. S. Altenbach, and D. E. Wilson. 1976. Bat mortality: pesticide poisoning and migratory stress. Science 194:184-186.

Grindal, S. D. 1996. Habitat use by bats in fragmented forests. Pages 260-272 *in* Bats and Forests Symposium (R. M. R. Barclay and R. M. Brigham, eds.), October 19-21, 1995. Research Branch, British Columbia Minister of Forests Research Program. Victoria, British Columbia, Canada.

Hall, E. R. 1981. *Myotis lucifugus*, little brown bat. Pages 191-194 *in* The mammals of North America, 2nd edition. Ronald Press, New York, New York. 1373 pp.

Hamilton, W. J., Jr. 1949. The bacula of some North American vespertilionid bats. Journal of Mammalogy 30:97-102.

Hayes, J. P. and M. D. Adam. 1996. The influence of logging riparian areas on habitat utilization by bats in western Oregon. *in* Bats and Forests Symposium (R. M. R. Barclay and R. M. Brigham, eds.), October 19-21, 1995. Research Branch, British Columbia Minister of Forests Research Program. Victoria, British Columbia, Canada. Victoria, B.C.

Heffernan, L. M. and G. G. Turner. 2016. The spread of White-nose Syndrome in North America and Pennsylvania, Chapter 8. *in* Conservation and ecology of Pennsylvania's bats (C.M. Butchkoski, D.M. Reeder, G.G. Turner, and H.P.

Whidden, eds.). Pennsylvania Academy of Science, East Stroudsburg, Pennsylvania. 267 pp.

Helms, J. S. 2010. Little bat and a big city: nocturnal behavior of the tricolored bat, (*Perimyotis subflavus*) near Indianapolis Airport.

Hoofer, S. R., R. A. Bussche, and I. Horacek. 2006. Generic status of the American pipistrelles (Vespertilionidae) with description of a new genus. Journal of Mammalogy 87:981-992.

Hoofer, S. R. and R. A. Van Den Bussche. 2003. Molecular phylogenetics of the Chiropteran family Vespertilionidae. Acta Chiropterologica (Supplemental) 5:1-63.

Hoying, K. M. and T. H. Kunz. 1998. Variation in size at birth and post-natal growth in the insectivorous bat *Pipistrellus subflavus* (Chiroptera: Vespertilionidae). Journal of Zoology (London) 245:15-27.

Humphrey, S. R. 1975. Nursery roosts and community diversity on Nearctic bats. Journal of Mammalogy 56:321-346.

Humphrey, S. R. and J. B. Cope. 1976. Population ecology of the little brown bat, *Myotis lucifugus*, in Indiana and north central Kentucky. Special Publication No. 4, American Society of Mammalogists. 81 pp.

Humphrey, S. R., A. R. Richter, and J. B. Cope. 1977. Summer habitat and ecology of the endangered Indiana bat, *Myotis sodalis*. Journal of Mammalogy 58:334-346.

Humphries, M. H., D. W. Thomas, and J. R. Speakman. 2002. Climate-mediated energetic constraints on the distribution of hibernating mammals. Nature 418:313-316.

IDNR. 2020. List of endangered, threatened, & rare species by county. Indiana Department of Natural Resources, Division of Nature Preserves, Natural Heritage Data Center, Indianapolis, Indiana. Available at: https://www.in.gov/dnr/naturepreserve/4666.htm.

Johnson, J. B., W. M. Ford, and J. W. Edwards. 2012. Roost networks of northern myotis (*Myotis septentrionalis*) in a managed landscape. Forest Ecology and Management 266:223–231.

Johnson, J. B., M. A. Menzel, J. W. Edwards, and W. M. Ford. 2002a. Gray bat night-roosting under bridges. Journal of the Tennessee Academy of Science 77:91-93.

Johnson, J. B., J. H. Roberts, T. L. King, J. W. Edwards, W. M. Ford, and D. A. Ray. 2013. Genetic structuring of northern myotis (*Myotis septentrionalis*) at multiple spatial scales. Acta Theriologica 59:223-231.

Johnson, J. S., M. R. Scafini, B. Sewall, and G. G. Turner. 2016. Hibernating bat species in Pennsylvania use colder winter habitats following the arrival of white-nose syndrome, Chapter 12. *in* Conservation and Ecology of Pennsylvania's Bats (C.M. Butchkoski, D.M. Reeder, G.G. Turner, and H.P. Whidden, eds.). Pennsylvania Academy of Science, East Stroudsburg, Pennsylvania. 267 pp.

Johnson, S. A., V. Brack, Jr., and R. K. Dunlap. 2002b. Management of hibernacula in the state of Indiana. Pages 100-109 *in* The Indiana Bat: Biology and Management of an Endangered Species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas.

Johnson, S. A., V. Brack, Jr., and R. E. Rolley. 1998. Overwinter weight loss of Indiana bats (*Myotis sodalis*) from hibernacula subject to human visitation. American Midland Naturalist 139:255-261.

Keeley, B. W. and M. D. Tuttle. 1999. Bats in American bridges. Resource Publication No. 4. Bat Conservation International, Inc. Austin, Texas.

Keen, R. and H. B. Hitchcock. 1980. Survival and longevity of the little brown bat (*Myotis lucifugus*) in southeastern Ontario. Journal of Mammalogy 61:1-7.

Kiser, J. D. and C. L. Elliott. 1996. Foraging habitat, food habits, and roost tree characteristics of the Indiana Bat (*Myotis sodalis)* during autumn in Jackson County, Kentucky. Unpublished report to Kentucky Department of Fish and Wildlife Resources. Frankfort, Kentucky. 75 pp.

Kiser, J. D., J. R. MacGregor, H. D. Bryan, and A. Howard. 2002. Use of concrete bridges as night roosts. Pages 208-215 *in* The Indiana Bat: Biology and Management of an Endangered Species (A. Kurta and J. Kennedy, eds.). Bat Conservation International. Austin, Texas.

Krochmal, A. R. and D. W. Sparks. 2007. Timing of birth and estimation of age of juvenile *Myotis septentrionalis* and *Myotis lucifugus* in west-central Indiana. Journal of Mammalogy 88:649-656.

Kunz, T. H. 1971. Reproduction of some vespertilionid bats in central Iowa. American Midland Naturalist 86:477-486.

Kunz, T. H. and J. Reichard. 2010. Status review of the little brown myotis (*Myotis lucifugus*) and determination that immediate listing under the endangered species act is scientifically and legally warranted. Boston University's Center for Ecology and Conservation Biology.

Kunz, T. H., J. A. Wrazen, and C. D. Burnett. 1998. Changes in body mass and fat reserves in prehibernating little brown bats (*Myotis lucifugus*). Ecoscience 5:8-17.

Kurta, A. 1995. Mammals of the Great Lakes Region. University of Michigan Press, Ann Arbor, Michigan.

Kurta, A. 2008. Bats of Michigan. Indiana State Center for North American Bat Research and Conservation, Publication 2.

Kurta, A., D. King, J. A. Teramino, J. M. Stribley, and K. J. Williams. 1993. Summer roosts of the endangered Indiana bat (*Myotis sodalis*) on the northern edge of its range. American Midland Naturalist 129:132-138.

Kurta, A. and T. H. Kunz. 1987. Size of bats at birth and maternal investment during pregnancy. Symposia of the Zoological Society of London 57:79-106.

Kurta, A. and S. W. Murray. 2002. Philopatry and migration of banded Indiana bats (*Myotis sodalis*) and effects of radio transmitters. Journal of Mammalogy 83:585-589.

Kurta, A., S. W. Murray, and D. H. Miller. 2002. Roost selection and movements across the summer landscape. Pages 118-129 *in* The Indiana Bat: Biology and Management of an Endangered Species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas.

Kurta, A., K. J. Williams, and R. Mies. 1996. Ecological, behavioral, and thermal observations of a peripheral population of Indiana bats (*Myotis sodalis*). Pages

102-117 *in* Bats and Forests Symposium (R. M. R. Barclay and R. M. Brigham, eds.), October 19-21, 1995. Research Branch, British Columbia Minister of Forests Research Program. Victoria, British Columbia, Canada.

Lacki, M. J., L. S. Burford, and J. O. Whitaker, Jr. 1995. Food habits of gray bats in Kentucky. Journal of Mammalogy 76:1256-1259.

Lacki, M. J. and J. H. Schwierjohann. 2001. Day-roost characteristics of northern bats in mixed mesophytic forests. The Journal of Wildlife Management 65:482-488.

LaVal, R. K., R. L. Clawson, M. L. LaVal, and W. Caire. 1977. Foraging behavior and nocturnal activity patterns of Missouri bats, with emphasis on the endangered species *Myotis grisescens* and *Myotis sodalis*. Journal of Mammalogy 58:592-599.

LaVal, R. K. and M. L. LaVal. 1980. Ecological studies and management of Missouri bats, with emphasis on cave-dwelling species. Missouri Department of Conservation: Terrestrial Series 8:1-53.

Lowe, A. J. 2012. Swarming behaviour and fall roost-use of little brown (*Myotis lucifugus*), and northern long-eared bats (*Myotis septentrionalis*) in Nova Scotia, Canada. Masters Thesis. St. Mary's University, Halifax, Nova Scotia, Canada.

Martin, C. O. 2007. Assessment of the population status of the gray bat (*Myotis grisescens*): Status review, DoD Initiatives, and results of a multi-agency effort to survey wintering populations at major hibernacula, 2005-2007. U.S. Army Corps of Engineers, Report ERDC/EL TR-07-22. Engineer Research and Development Center, Vicksburg, Mississippi.

Maslo, B., M. Valent, J. F. Gumbs, and W. F. Frick. 2015. Conservation implications of ameliorating survival of little brown bats with white-nose syndrome. Ecological Applications 25:1832-1840.

Mayberry, H. W., L. P. McGuire, and C. K. R. Willis. 2018. Body temperatures of hibernating little brown bats reveal pronounced behavioural activity during deep torpor and suggest a fever response during white-nose syndrome. Journal of Comparative Physiology B 188:333-343.

McNab, B. K. 1974. The behavior of temperate cave bats in a subtropical environment. Ecology 55:943-958.

Menu, H. 1984. Revision du statut de PIPISTRELLUS SUBFLAVUS (F. Cuvier, 1832). Proposition d'un taxon generique nouveau: PERIMYOTIS nov. gen. Mammalia 48:409-416.

Menzel, J. M., M. A. Menzel, J. C. Kilgo, W. M. Ford, J. W. Edwards, and G. F. McCracken. 2005. Effect of habitat and foraging height on bat activity in the coastal plain of South Carolina. Journal of Wildlife Management 69:235-245.

Miller, N. E., R. D. Drobney, R. L. Clawson, and E. V. Callahan. 2002. Summer habitat in northern Missouri. Pages 165-171 *in* The Indiana Bat: Biology and Management of an Endangered Species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas.

Mohr, C. E. 1972. The status of threatened species of cave-dwelling bats. Pages 33-47 *in* Cave Bats: Their Ecology, Physiology, Behavior, and Future Survival. A Symposium with Recommendations. Bulletin of the National Speleological Society. Huntsville, Alabama.

Moore, P. R., T. S. Risch, D. K. Morris, and L. B. McNew. 2017. Habitat use of female gray bats assessed using aerial telemetry. Journal of Wildlife Management 81:1242-1253.

Mumford, R. E. and J. B. Cope. 1964. Distribution and status of the Chiroptera of Indiana. American Midland Naturalist 72:473-489.

Norberg, U. M. and J. M. V. Rayner. 1987. Ecological morphology and flight in bats (Mammalia; Chiroptera): wing adaptations, flight performance, foraging strategy and echolocation. Philosophical Transactions of the Royal Society of London B: Biological Sciences 316:335-427.

Parsons, K. N., G. Jones, I. Davidson-Watts, and F. Greenaway. 2003. Swarming of bats at underground sites in Britain-implications for conservation. Biological Conservation 111:63-70.

Perry, R. W. and R. E. Thill. 2007a. Roost selection by male and female northern long-eared bats in a pine-dominated landscape. Forest Ecology and Management 247:220-226.

Perry, R. W. and R. E. Thill. 2007b. Tree roosting by male and female eastern pipistrelles in a forested landscape. Journal of Mammalogy 88:974–981.

Perry, R. W., R. E. Thill, and D. M. Leslie, Jr. 2007. Selection of roosting habitat by forest bats in a diverse forested landscape. Forest Ecology and Management 238:156-166.

Poissant, J., H. G. Broders, and G. M. Quinn. 2010. Use of lichen as a roosting substrate by *Perimyotis subflavus*, the tricolored bat, in Nova Scotia. Ecoscience 17:372-378.

Randall, J. and H. G. Broders. 2014. Identification and characterization of swarming sites used by bats in Nova Scotia, Canada. Acta Chiropterologica 16:109-116.

Randall, L. A., R. M. R. Barclay, M. L. Reid, and T. S. Jung. 2011. Recent infestation of forest stands by spruce beetles does not predict habitat use by little brown bats (*Myotis lucifugus*) in southwestern Yukon, Canada. Forest Ecology and Management 261:1950–1956.

Reeder, D. M., C. L. Frank, G. G. Turner, C. U. Meteyer, A. Kurta, E. R. Britzke, M. E. Vodzak, S. R. Darling, C. W. Stihler, A. C. Hicks, R. Jacob, L. E. Grieneisen, S. A. Brownlee, L. K. Muller, and D. S. Blehert. 2012. Frequent arousal from hibernation linked to severity of infection and mortality in bats with white-nose syndrome. PLoS ONE 7:1-10.

Reeder, D. M., G. Turner, A. H. Robbins, H. D. Barton, M. A. Ghannoum, A. C. Hicks, E. L. Buckles, S. Brownlee, L. Grieneisen, S. E. Alfano, and H. Fischer. 2010. Mitigating white-nose syndrome: results of captive treatment trials, behavioral observations, microclimate variation, and explorations of immune responses to WNS. *in* Proceedings of White-nose Syndrome Symposium May 25-27, 2010, Pittsburgh, Pennsylvania.

Richter, A. R., S. T. Humphrey, J. B. Cope, and V. Brack, Jr. 1993. Modified cave entrances: thermal effect on body mass and resulting decline of endangered Indiana bats (*Myotis sodalis*). Conservation Biology 7:407-415.

Sasse, D. B., R. Clawson, M. J. Harvey, and S. L. Hensley. 2007. Status of populations of the endangered gray bat in the western portion of its range. Southeastern Naturalist 6:165-172.

Sasse, D. B. and P. J. Pekins. 1996. Summer roosting ecology of northern long-eared bats (*Myotis septentrionalis*) in the White Mountain National Forest. Pages 91-101 *in* Bats and Forests Symposium (R. M. R. Barclay and R. M. Brigham, eds.), October 19-21, 1995. Research Branch, British Columbia Minister of Forests Research Program. Victoria, British Columbia, Canada.

Schmidt, A., V. Brack, Jr., R. Rommé, K. Tyrell, and A. Gehrt. 2001. Bioaccumulation of pesticides in bats from Missouri. Pages 8-21 *in* Pesticides and Wildlife (J. J. Johnston, ed.). American Chemical Society Symposium No. 771.

Schoener, T. W. and D. H. Janzen. 1968. Notes on environmental determinants of tropical versus temperate insect size patterns. The American Naturalist 102:207-224.

Schultes, K. L. and C. L. Elliott. 2002. Roost tree selection by Indiana bats and northern bats on the Wayne National Forest, Ohio. Unpublished report to U.S. Fish & Wildlife Service, Reynoldsburg, Ohio Field Office and U.S. Department of Agriculture, Forest Service, Wayne National Forest.

Sheets, J. J., J. O. Whitaker Jr., V. Brack Jr., and D. W. Sparks. 2013. Bats of the hardwood ecosystem experiment before timber harvest: assessment and prognosis. Pages 191-202 *in* The Hardwood Ecosystem Experiment: a framework for studying responses to forest management (R. K. Swihart, M. R. Saunders, R. A. Kalb, G. S. Haulton, C. H. Michler, eds.). General Technical Report NRS-P-108. U.S. Department of Agriculture, Forest Service, Northern Research Station. Newtown Square, Pennsylvania.

Silvis, A., W. M. Ford, E. R. Britzke, N. R. Beane, and J. B. Johnson. 2012. Forest succession and maternity day roost selection by *Myotis septentrionalis* in a mesophytic hardwood forest. International Journal of Forestry Research. 8p.

Silvis, A., W. M. Ford, E. R. Britzke, and J. B. Johnson. 2014. Association, roost use and simulated disruption of *Myotis septentrionalis* maternity colonies. Behavioural Processes 103:283–290.

Sparks, D. W. 2003. How does urbanization impact bats? Ph.D. Dissertation. Indiana State University, Terre Haute, Indiana. 121 pp.

Sparks, D. W. and J. R. Choate. 2000. Distribution, natural history, conservation status, and biogeography of bats in Kansas. Pages 173-228 *in* Reflections of a naturalist: Papers honoring professor Eugene D. Fleharty (J. R. Choate, ed.). Fort Hays Studies, Special Issue 1:1-241.

Sparks, D. W., C. J. Schmidt, and J. R. Choate. 2011. Bats of Kansas. Publication Number 5, Indiana State University Center for North American Bat Research and Conservation. 62 pp.

The Center for Biological Diversity and Defenders of Wildlife. 2016. Petition to list the tricolored bat *Perimyotis subflavus* as threatened or endangered under the Endangered Species Act. Petition submitted to the U.S. Secretary of the Interior, acting through the U.S. Fish and Wildlife Service. The Center for Biological Diversity, Tucson, Arizona and Defenders of Wildlife, Washington D.C. 76pp.

Thomas, D. W., M. Dorais, and J. M. Bergeron. 1990. Winter energy budgets and cost of arousals for hibernating little brown bats, *Myotis lucifigus*. Journal of Mammalogy 71:475-479.

Thomas, D. W. and F. Geiser. 1997. Periodic arousals in hibernating mammals: is evaporative water loss involved? Functional Ecology 11:585-591.

Tibbels, A. E. and A. Kurta. 2003. Bat activity is low in thinned and unthinned stands of red pine. Canadian Journal of Forest Research 33 (12):2436-2442.

Timpone, J. C. 2004. Roost-site selection of bats in the northeast Missouri with emphasis on the endangered Indiana bat (*Myotis sodalis*). Masters thesis, Southwest Missouri State University. 71pp.

Timpone, J. C., J. G. Boyles, K. L. Murray, D. P. Aubrey, and L. W. Robbins. 2010. Overlap in roosting habits of Indiana bats (*Myotis sodalis*) and northern bats (*Myotis septentrionalis*). American Midland Naturalist 163:115-123.

Tinsley, K. 2016. Status review for the eastern subspecies of the little brown bat (*Myotis lucifugus lucifugus*). Prepared for U.S. Department of Interior, U.S. Fish and Wildlife Service, Region 3, Bloomington, Minnesota. 150 pp.

Turner, G. G., D. M. Reeder, and J. T. H. Coleman. 2011. A five-year assessment of mortality and geographic spread of white-nose syndrome in North American bats and a look to the future. Bat Research News 52:13-27.

Turner, J. M., L. Warnecke, A. Wilcox, D. Baloun, T. K. Bollinger, V. Misra, and C. K. R. Willis. 2015. Conspecific disturbance contributes to altered hibernation patterns in bats with white-nose syndrome. Physiology & Behavior 140:71–78.

Tuttle, M. D. 1976a. Population ecology of the gray bat (*Myotis grisescens*): Factors influencing growth and survival of newly volant young. Ecology 57:587-595.

Tuttle, M. D. 1976b. Population ecology of the gray bat (*Myotis grisescens*):Philopatry, timing and patterns of movement, weight loss during migration, and seasonal adaptive strategies. Pages 1-38 *in* Occasional Papers from the Museum of Natural History, University of Kansas.

Tuttle, M. D. 1979. Status, causes of decline, and management of endangered gray bats. Journal of Wildlife Management 43:1-17.

Tuttle, M. D. and D. Stevenson. 1982. Growth and survival of bats. Pages 105-150 *in* Ecology of bats (T. H. Kunz, ed.) Plenum Press, New York, New York. 425pp.

Twente, J. W., J. Twente, and V. Brack, Jr. 1985. The duration of the period of hibernation of three species of vespertilionid bats. II: Laboratory studies. Canadian Journal of Zoology 63:2955-2961.

USFS. 2005. Mark Twain National Forest, Missouri: programmatic biological assessment forest plan revision. U.S. Department of Agriculture, Forest Service, Eastern Region, Milwaukee, Wisconsin. 303 pp.

USFWS. 1997. Endangered species – gray bat. U.S. Department of Interior, Fish and Wildlife Service, Fort Snelling, Minnesota.

USFWS. 2007. Indiana bat (*Myotis sodalis*) draft recovery plan: First revision. U.S. Department of Interior, Fish and Wildlife Service, Fort Snelling, Minnesota. 258 pp.

USFWS. 2013. Northern long-eared bat (*Myotis septentrionalis*) fact sheet. U.S. Department of Interior, Fish and Wildlife Service.

USFWS. 2016. Programmatic biological opinion on final 4(d) rule for the northern long-eared bat and activities excepted from take prohibitions. U.S. Department of the Interior, Fish and Wildlife Service, Midwest Regional Office, Bloomington, Minnesota. 103 pp.

USFWS. 2017. Endangered and threatened wildlife and plants; 90-day findings for five species. Pages 60362-60366 *in* Federal Register Volume 82, No. 243. U.S. Department of the Interior, Fish and Wildlife Service.

USFWS. 2019. 2019 Indiana bat (*Myotis sodalis*) population status update. U.S. Department of the Interior, Fish and Wildlife Service, Indiana Ecological Services Field Office, Bloomington, Indiana. 9 pp.

USFWS. 2020. Three bat species assessment. Email from John Jaka, U.S. Department of Interior, Fish and Wildlife Service, Great Lakes Regional Office, Bloomington, Minnesota to Midwest Conservation Partners.

Valdez, E. W., K. Geluso, J. Foote, G. Allison-Kosior, and D. M. Roemer. 2009. Spring and winter records of the eastern pipistrelle (*Perimyotis subflavus*) in southeastern New Mexico. Western North American Naturalist 69:396-398.

Veilleux, J. P. and S. L. Veilleux. 2004a. Colonies and reproductive patterns of tree-roosting female eastern pipistrelle bats in Indiana. Proceedings of the Indiana Academy of Science 113:60-65.

Veilleux, J. P. and S. L. Veilleux. 2004b. Intra-annual and interannual fidelity to summer roost areas by female eastern pipistrelles, *Pipistrellus subflavus*. The American Midland Naturalist 152:196-200.

Veilleux, J. P., J. O. Whitaker, Jr, and S. L. Veilleux. 2003. Tree-roosting ecology of reproductive female eastern Pipistrelles, *Pipistrellus subflavus*, in Indiana. Journal of Mammalogy 84:1068-1075.

Veilleux, J. P., J. O. Whitaker, Jr, and S. L. Veilleux. 2004. Reproductive stage influences roost use by tree roosting female eastern pipistrelles, *Pipistrellus suflavus*. Ecoscience 11:249-256.

Verant, M. L., J. G. Boyles, W. Waldrep, Jr, G. Wibbelt, and D. S. Blehert. 2012. Temperature-dependent growth of *Geomyces destructans*, the fungus that causes bat white-nose syndrome. PLoS ONE 7:1-7.

Verant, M. L., C. U. Meteyer, J. R. Speakman, P. M. Cryan, J. M. Lorch, and D. S. Blehert. 2014. White-nose syndrome initiates a cascade of physiologic disturbances in the hibernating bat host. BMC Physiology 14:1-10.

Warnecke, L., J. M. Turner, T. K. Bollinger, J. M. Lorch, V. Misra, P. M. Cryan, G. Wibbelt, D. S. Blehert, and C. K. R. Willis. 2012. Inoculation of bats with European *Geomyces destructans* supports the novel pathogen hypothesis for the origin of white-nose syndrome. Proceedings of the National Academy of Sciences 109:6999-7003.

WDNR. 2013. Eastern pipistrelle (*Perimyotis subflavus*) species guidance. Wisconsin Department of Natural Resources, Bureau of Natural Heritage Conservation.

Whitaker, J. O., Jr. 1972. Food habits of bats from Indiana. Canadian Journal of Zoology 50:877-883.

Whitaker, J. O., Jr. 1998. Life history and roost switching in six summer colonies of eastern pipistrelles in buildings. Journal of Mammalogy 79:651-659.

Whitaker, J. O., Jr, A. Kurta, and T. C. Carter. 2011. Retention of the common name eastern pipistrelle for *Perimyotis subflavus*. Bat Research News 52:53-54.

Whitaker, J. O., Jr and L. J. Rissler. 1992. Seasonal activity of bats at Copperhead Cave. Proceedings of the Indiana Academy of Science 101:127-134.

Whitaker, J. O., Jr. 2004. Prey selection in a temperate zone insectivorous bat community. Journal of Mammalogy 85:460–469.

Whitaker, J. O., Jr. and V. Brack, Jr. 2002. Distribution and summer ecology in Indiana. Pages 48-54 *in* The Indiana Bat: Biology and Management of an Endangered Species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas.

Whitaker, J. O., Jr., V. Brack, Jr., D. W. Sparks, J. B. Cope, and S. Johnson. 2007. Bats of Indiana. Publication number 1. Indiana State University, Center for North American Bat Research and Conservation. 59 pp.

Whitaker, J. O., Jr., J. B. Cope, and V. Brack, Jr. 2003. Bats of Wyandotte Cave, Crawford County, Indiana. Proceedings of the Indiana Academy of Science 112:75-84.

Whitaker, J. O., Jr. and R. E. Mumford. 2009. Mammals of Indiana. Indiana University Press. Bloomington, Indiana, 661 pp.

Whitaker, J. O., Jr., D. W. Sparks, and V. Brack, Jr. 2004. Bats of the Indianapolis International airport area, 1991–2001. Proceedings of the Indiana Academy of Science 113:151-161.

Whitaker, J. O., Jr., D. W. Sparks, and V. Brack, Jr. 2006. Use of artificial roost structures by bats at the Indianapolis International Airport. Environmental Management 38:28-36.

Whitaker, J. O., Jr., B. L. Walters, J. P. Veilleux, and R. O. Davis. 2014. Occurrence and suspected function of prematernity colonies of eastern pipistrelles, *Perimyotis subflavus*, in Indiana. Proceedings of the Indiana Academy of Science 123:49-56.

White, J. A., J. Moosman, P, C. H. Kilgore, and T. L. Best. 2006. First record of the eastern pipistrelle (*Pipistrellus subflavus*) from southern New Mexico. The Southwestern Naturalist 51:420-422.

WIDNR. 2017. Notes on radio-tracking of two eastern pipistrelles (*Perimyotis subflavus*) during spring emergence. Prepared by Wisconsin Department of Natural Resources. 15 pp.

Wilcox, A., L. Warnecke, J. M. Turner, L. P. McGuire, J. W. Jameson, V. Misra, T. C. Bolligner, and C. K. Willis. 2014. Behaviour of hibernating little brown bats experimentally inoculated with the pathogen that causes white-nose syndrome. Animal Behavior 88:157-164.

Wimsatt, W. A. 1945. Notes on breeding behavior, pregnancy, and parturition in some vespertilionid bats of the eastern United States. Journal of Mammalogy 26:23-33.

Wray, A. K., M. A. Jusino, M. T. Banik, J. M. Palmer, H. Kaarakka, J. P. White, D. L. Lindner, C. Gratton, and M. Z. Peery. 2018. Incidence and taxonomic richness of mosquitoes in the diets of little brown and big brown bats. Journal of Mammalogy 99:668-674.

APPENDIX B
DATASHEETS

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue, Cincinnati, OH 45232 (Phone: 513-451-1777)

HABITAT ASSESSMENT

Project #: 1562 **Date:** 16 July 2020 **State:** IN **County:** Jackson

Project Name: INFA Bat Bridges **Site Name/#:** 1562-AS-001 **USGS Quad:** Owls

Permitted Biologist: Michael Marcos (full name) Other Field Staff: _____ (full name) State Permit #: _____ Federal Permit #: _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
D	SMU07512	39.01895372 °N	86.30112389 °W	TRAP	VOID
		°N	°W		
		°N	°W		
		°N	°W		

Distance to closest water source (meters): 10 Type of water source: Pond

Water source name: Unknown

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____meters Channel Width: _____meters Stream Width: _____meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ____m or cm Clarity (H,M,L): ____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)	Subdominant Canopy Species (< 40 cm/16" dbh)
Quercus montana	Sassafras albidum
Pinus virginiana	Nyssa sylvatica
Quercus rubra	Cornus florida

Estimated dbh range: Lg: 65 Sm: 10 Estimated dbh range: Lg: 39 Sm: 10

Relative abundance of dominant vs. subdominant (ratio): 10:1

Estimated canopy closure: ___Closed X Moderate ___Open

Roost tree potential consists of: ___Hollow X Large Trees X Snags ___ Neither

M. sodalis roost tree potential is: ___High X Moderate ___Low

Roost potential comments: Good roosting, but not high for MSYEO

M. septentrionalis roost tree potential is: X High ___Moderate ___Low

Roost potential comments: Good abundance of suitable MSYE roost.

Subcanopy clutter: ___Closed ___Moderate X Open

Subcanopy consists largely of: ___ Lower Branches of Canopy Trees X Saplings ___Shrubs

Common Subcanopy Species: Smilax sp. Parthenocissus sp. Toxicodendron radicans

Check all that apply:

X Mature Upland Forest	___Recently Logged Forest	___Crop/Pasture Land	Other _____
___Young Upland Forest	X Forest Edge	___Stream/River	_____
___Mature Lowland Forest	___Woodlot	___Vernal Pool	_____
___Young Lowland Forest	___Old Field	X Deepwater Lake/Pond	_____

Herbaceous Cover: X Sparse ___Moderate ___Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

Project #: 1562	State/County: IN / Jackson	Site Name/#: AS-001	Initials: MCM

SKETCH NETS and/or DETECTORS

N

LEGEND

Net:

Detector:

DETAILED HABITAT DESCRIPTION & COMMENTS

Open field bordering pond and large forested area.

ESI

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: 10 July 2020

Project Name: INFA Rob's Bridges Site Name#: 1562-AS-001

State: IN County: Jackson

GPS Unit#: IPAD Camera/iPAD #: IPAD

Biologist (Full name) selected site Michael Marrose

Biologist (Full name) deployed detector

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
SMU07222	39.0189527 2 °N	-86.30112389 °W	2040	0700	IPAD	IPAD	IPAD

Provide: Information about the Detector & Microphone

___ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)

___SM 3 (___U1 or ___U2 micropone), X SM 4 (U2) ____ Mini (U2)_

___ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ____ABII and ZCAIM

Microphone Type____Standard (Black) ___ High (Green) or ___Stainless steel_

Detector Placement/Site Description: Green woodland field very round.

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 10 (ft)
Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 4000 (ft)
Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? 150 (ft)
Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°)
SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? 100 (ft)
Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☒yes ☐no
If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☑Omni Directional

How high (ft) is the microphone above ground level? 10 (ft)
Compliance = 10 feet

Are calls recorded in :
☑ Full Spectrum
☒ Zero Crossing

3. Is the gear working? ☒yes ☐no

Checked by (name) Marrose at 16:36 (Time)

4. Is detector water-proofed? ☒Yes ☐No

MM Initial

5. What is the temperature____ (°F)?
Compliance= >50 degrees F

What is the wind speed (mph)____?
Compliance = <9 mph sustained

____ Precipitation for 30 minutes straight or intermittent the first 5 hours

Revised May 2020

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT

Project #: 1562 Date: 10 July 2020 State: IN County: Jackson

Project Name: IFA Boest Bats Site Name/#: 1562-AS-002 USGS Quad: _____

Permitted Biologist: Rob Jean (full name) Other Field Staff: Michelle Jean (full name) State Permit #: _____

Federal Permit #: _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
D	SMU00949	38.966059 °N	-86.300511 °W	Ipad	Ipad
		°N	°W		
		°N	°W		
		°N	°W		

Distance to closest water source (meters): 100m Type of water source: Ephemeral stream

Water source name: Unnamed stream

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____meters Channel Width: _____meters Stream Width: _____meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ____m or cm Clarity (H,M,L):____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)

Red Oak
Chestnut Oak
Am. Beech

Subdominant Canopy Species (< 40 cm/16" dbh)

Sassafras
Beech
Ash

Estimated dbh range: Lg: 30-40 Sm: 15-30 Estimated dbh range: Lg: 5-15 Sm: 0-5

Relative abundance of dominant vs. subdominant (ratio): 1:5

Estimated canopy closure: ___Closed X Moderate ___Open

Roost tree potential consists of: X Hollow X Large Trees X Snags ___ Neither

M. sodalis roost tree potential is: ___High X Moderate ___Low

Roost potential comments: A few snags, large trees w/ ok solar exposure

M. septentrionalis roost tree potential is: ___High X Moderate ___Low

Roost potential comments: A few snags and hollows in oak trees

Subcanopy clutter: ___Closed X Moderate ___Open

Subcanopy consists largely of: ___ Lower Branches of Canopy Trees X Saplings ___Shrubs

Common Subcanopy Species: Sassafras Ash Chestnut oak

Check all that apply:

X Mature Upland Forest
___Young Upland Forest
___Mature Lowland Forest
X Young Lowland Forest
___Recently Logged Forest
X Forest Edge
___Woodlot
X Old Field
___Crop/Pasture Land
___Stream/River
___Vernal Pool
___Deepwater Lake/Pond
Other _____

Herbaceous Cover: ___ Sparse X Moderate ___Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

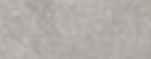
Project #:	State/County:	Site Name/#:	Initials:

SKETCH NETS and/or DETECTORS

N

LEGEND

Net: ●——●

Detector: 

DETAILED HABITAT DESCRIPTION & COMMENTS

Shrubby opening in deciduous forest with many red oak, sassafras, and ash seedlings. Some forbs & grass but mainly brambles & seedlings. Forest dominated by mature chestnut oak, red/black oak and American beech.

2020

ESI

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: 10-Jul-2020
Project Name: IFA Bee & Bats Site Name#: 1562-A5-002
State: IN County: Jackson
GPS Unit#: Camera/IPAD #:
Biologist (Full name) selected site Robert Jean
Biologist (Full name) deployed detector Robert Jean

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET 14:52

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
SMU00949	38.996059 "N	-86:30051 "W	20:42	6:59	Ipad		

Provide: Information about the Detector & Microphone

___ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)	___ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ___ABII and ZCAIM
____SM 3 (___U1 or ___U2 micropone), ____SM 4 (U2) X Mini (U2)_	Microphone Type____Standard (Black) ___ High (Green) or ___Stainless steel_

Detector Placement/Site Description:

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 10 (ft)
Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 2450 (ft)
Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? 233 (ft)
Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°)
SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? N/A (ft)
Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☒yes ☐no
If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☒Omni Directional

How high (ft) is the microphone above ground level? 10 (ft)
Compliance = 10 feet

Are calls recorded in :
☒ Full Spectrum
☐ Zero Crossing

3. Is the gear working? ☒yes ☐no — Checked by (name) Robert Jean at 1453 (Time)

4. Is detector water-proofed? ☒Yes ☐No ____Initial

5. What is the temperature 93 (°F)?
Compliance= >50 degrees F

What is the wind speed (mph) 4 ?
Compliance = <9 mph sustained

____ Precipitation for 30 minutes straight or intermittent the first 5 hours

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

HABITAT ASSESSMENT

Project #: 1562 Date: 10-Jul-2020 State: IN County: Jackson

Project Name: I-F-A Bees Bats Site Name/#: 1562-AS-003 USGS Quad: _____

Permitted Biologist: Robert Jean (full name) Other Field Staff: Michelle Jay (full name) State Permit #: _____

Federal Permit #: _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude		Longitude		Picture #	Waypoint #
	SM400952	38.989352	°N	-86.303092	°W	Ipad	Ipad
			°N		°W		
			°N		°W		
			°N		°W		

Distance to closest water source (meters): 500 Type of water source: Stream

Water source name: Starnes Branch (East)

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____meters Channel Width: _____meters Stream Width: _____meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ____m or cm Clarity (H,M,L): ____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)

Tulip
Red Oak
Walnut

Subdominant Canopy Species (< 40 cm/16" dbh)

Sassafras
Sugar Maple
Red Oak

Estimated dbh range: Lg: 20-35 Sm: 16-20 Estimated dbh range: Lg: 3-10 Sm: 0-3

Relative abundance of dominant vs. subdominant (ratio): 1:5

Estimated canopy closure: ___Closed X Moderate ___Open

Roost tree potential consists of: ___Hollow X Large Trees ___Snags ___ Neither

M. sodalis roost tree potential is: ___High X Moderate ___Low

Roost potential comments: Sloughing bark on a few trees w/good solar exposure

M. septentrionalis roost tree potential is: ___High ___Moderate X Low

Roost potential comments: Most trees smaller with few hollows

Subcanopy clutter: ___Closed X Moderate ___Open

Subcanopy consists largely of: ___ Lower Branches of Canopy Trees X Saplings ___Shrubs

Common Subcanopy Species: Autumn olive Sumac S. Maple

Check all that apply:

X Mature Upland Forest
X Young Upland Forest
__Mature Lowland Forest
__Young Lowland Forest
__Recently Logged Forest
X Forest Edge
__Woodlot
X Old Field
__Crop/Pasture Land
__Stream/River
__Vernal Pool
__Deepwater Lake/Pond
Other _____

Herbaceous Cover: ___ Sparse ___Moderate X Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue, Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

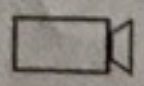
Project #:	State/County:	Site Name/#:	Initials:

SKETCH NETS and/or DETECTORS

N

LEGEND

Net: ●——●

Detector: 

DETAILED HABITAT DESCRIPTION & COMMENTS

Wildlife opening with scattered shrubs and many forbs & grass. Forest dominated by tulip, oak, and walnut w/ autumn olive, ~~sugar~~ maple & sassafras in understory

2020

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: 10-Jul-2020
Project Name: IFA Bees & Bats Site Name#: 1562-AS-003
State: IN County: Jackson
GPS Unit#: Camera/IPAD #:
Biologist (Full name) selected site Robert Jean
Biologist (Full name) deployed detector Robert Jean

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
(8-12)	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET 13:50

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
SMU00952	38.989352 "N	-86.303092 "W	20:42	6:59	Ipad	Ipad	Ipad

Provide: Information about the Detector & Microphone

___ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)	___ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ___ABII and ZCAIM
___SM 3 (___U1 or ___U2 micropone), ___SM 4 (U2) X Mini (U2)_	Microphone Type___Standard (Black) ___ High (Green) or ___Stainless steel_

Detector Placement/Site Description:

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 10 (ft) Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 2500 (ft) Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? >33 (ft) Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°) SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? N/A (ft) Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☒yes ☐no If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☒Omni Directional

How high (ft) is the microphone above ground level? 10 (ft) Compliance = 10 feet

Are calls recorded in : ☒Full Spectrum ☐ Zero Crossing

3. Is the gear working? ☒yes ☐no Checked by (name) Robert Jean at 14:00 (Time)

4. Is detector water-proofed? ☒Yes ☐No _____Initial

5. What is the temperature 82.5 (°F)? Compliance= >50 degrees F

What is the wind speed (mph) 8 ? Compliance = <9 mph sustained

_____ Precipitation for 30 minutes straight or intermittent the first 5 hours

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

HABITAT ASSESSMENT

Project #: 1562 Date: 10-Jul-2020 State: IN County: Jackson

Project Name: IFA Bees & Bats Site Name/#: 1562-As-005 USGS Quad: _____

Permitted Biologist: Robert Jean (full name) Other Field Staff: Michelle Jean (full name) State Permit #: _____

Federal Permit #: _____

Net/Trap/ (Detector)	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
	SM400868	38.973091 °N	86.288749 °W	Ipad	Ipad
		°N	°W		
		°N	°W		
		°N	°W		

Distance to closest water source (meters): 234 Type of water source: Pond

Water source name: Unnamed pond

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____meters Channel Width: _____meters Stream Width: _____meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ____m or cm Clarity (H,M,L):____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)	Subdominant Canopy Species (< 40 cm/16" dbh)
Sugar Maple	Red bud
Tulip tree	Tulip tree
Red Maple	Red Maple

Estimated dbh range: Lg: 20-40 Sm: 16-20 Estimated dbh range: Lg: 5-16 Sm: 0-5

Relative abundance of dominant vs. subdominant (ratio): 1:4

Estimated canopy closure: ___Closed X Moderate ___Open

Roost tree potential consists of: ___Hollow ___Large Trees X Snags ___ Neither

M. sodalis roost tree potential is: ___High X Moderate ___Low

Roost potential comments: Few snag and several trees w/ sloughing bark + good exposure

M. septentrionalis roost tree potential is: ___High ___Moderate X Low

Roost potential comments: Few snags

Subcanopy clutter: ___Closed X Moderate ___Open

Subcanopy consists largely of: ___ Lower Branches of Canopy Trees X Saplings ___Shrubs

Common Subcanopy Species: red maple Rosa multiflora tulip tree

Check all that apply:

__Mature Upland Forest	__Recently Logged Forest	__Crop/Pasture Land	Other _____
X Young Upland Forest	X Forest Edge	__Stream/River	_____
__Mature Lowland Forest	__Woodlot	__Vernal Pool	_____
__Young Lowland Forest	X Old Field	__Deepwater Lake/Pond	_____

Herbaceous Cover: ___ Sparse ___Moderate X Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

Project #:	State/County:	Site Name/#:	Initials:

SKETCH NETS and/or DETECTORS

N

LEGEND

Net: ●——●

Detector: ▭

DETAILED HABITAT DESCRIPTION & COMMENTS

●——● Natural gas ROW with many shrub, forbs & small trees. Forest dom. by red, sugar maple, tulip w/ sub of Rosa, Rubus, Acer & Forbs include Monarda & Pycnanthemum

2020

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: 10-Jul-2020
Project Name: IFA Bee&Bats Site Name#: 1562-AS-005
State: IN County: Jackson
GPS Unit#: Camera/IPAD #:
Biologist (Full name) selected site Robert Jean
Biologist (Full name) deployed detector Robert Jean

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

15133
3:30

FILL IN THE FOLLOWING FOR EACH DETECTOR SET

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
SMU00868	38.973091 "N	-86.288749 "W	20:42	6:59	Ipad	Ipad	

Provide: Information about the Detector & Microphone

___ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)
___SM 3 (___U1 or ___U2 micropone), ___SM 4 (U2) X Mini (U2)_

___ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ___ABII and ZCAIM
Microphone Type___Standard (Black) ___ High (Green) or ___Stainless steel_

Detector Placement/Site Description:

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 10 (ft)
Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 7209 (ft)
Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? >100 (ft)
Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°)
SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? VARIES (ft)
Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☒yes ☐no
If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☒Omni Directional

How high (ft) is the microphone above ground level? 10 (ft)
Compliance = 10 feet

Are calls recorded in :
☒Full Spectrum
☐ Zero Crossing

3. Is the gear working? ☒yes ☐no

Checked by (name) Robert Jean at 3:30 (Time)

4. Is detector water-proofed? ☒Yes ☐No

_____Initial

5. What is the temperature 72 (°F)?
Compliance= >50 degrees F

What is the wind speed (mph) 8 ?
Compliance = <9 mph sustained

____ Precipitation for 30 minutes straight or intermittent the first 5 hours

2019

HABITAT ASSESSMENT

Project #: 1562 Date: 10-Jul-2020 State: IN County: Jackson

Project Name: IFA Beest Site Name/#: 1562-AS-08 USGS Quad: _____

Permitted Biologist: Robert Jean (full name) Other Field Staff: Michelle Jean (full name) State Permit #: _____

Federal Permit #: _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
	SM400785	38.996341 °N	-86.263347 °W	Ipad	Ipad
		°N	°W		
		°N	°W		
		°N	°W		

Distance to closest water source (meters): 176 Type of water source: wetland

Water source name: Wetland (unnamed)

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____meters Channel Width: _____meters Stream Width: _____meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ____m or cm Clarity (H,M,L):____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)
Tulip
White Pine
Sugar Maple

Subdominant Canopy Species (< 40 cm/16" dbh)
Black locust
Sumac
Salix

Estimated dbh range: Lg: 16-20 Sm: 5-15

Estimated dbh range: Lg: 5-15 Sm: 1-4

Relative abundance of dominant vs. subdominant (ratio): 1:2

Estimated canopy closure: ___Closed X Moderate ___Open

Roost tree potential consists of: ___Hollow ___Large Trees X Snags ___ Neither

M. sodalis roost tree potential is: ___High X Moderate ___Low

Roost potential comments: Some sloughing bark and one snag w descent solar exposure

M. septentrionalis roost tree potential is: ___High ___Moderate X Low

Roost potential comments: One snag w/ descent solar exposure but few cavities avail,

Subcanopy clutter: ___Closed X Moderate ___Open

Subcanopy consists largely of: ___ Lower Branches of Canopy Trees X Saplings ___Shrubs

Common Subcanopy Species: Black locust Sumac Autumn olive

Check all that apply:

___Mature Upland Forest
X Young Upland Forest
___Mature Lowland Forest
___Young Lowland Forest
___Recently Logged Forest
X Forest Edge
___Woodlot
X Old Field ROW
___Crop/Pasture Land
___Stream/River
___Vernal Pool
___Deepwater Lake/Pond
Other _____

Herbaceous Cover: ___ Sparse ___Moderate X Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

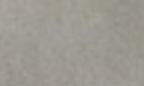
Project #:	State/County:	Site Name/#:	Initials:

SKETCH NETS and/or DETECTORS

N

LEGEND

Net: ●——●

Detector: 

DETAILED HABITAT DESCRIPTION & COMMENTS

Natural gas pipeline ROW w/ scattered autumn olive, sumac, willow & black locust - forbs & grasses abundant
Forest dom. by tulip & maple

2020

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: 10-Jul-2020
Project Name: IFA Bees & Bats Site Name#: 1562-AS-08
State: IN County: Jackson
GPS Unit#: Camera/IPAD #:
Biologist (Full name) selected site Robert Jean
Biologist (Full name) deployed detector Robert Jean

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
(8-12)	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET 1:00pm.

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
SMU00785	38.996341 °N	-86.263347 °W	20:42	6:59	Ipad	Ipad	Ipad

Provide: Information about the Detector & Microphone

____Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)	____ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ____ABII and ZCAIM
____SM 3 (___U1 or ___U2 micropone), ____SM 4 (U2) X Mini (U2)_	Microphone Type_____Standard (Black) ___ High (Green) or ___Stainless steel_

Detector Placement/Site Description:

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 20 (ft) Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 2,050 (ft) Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? >33 (ft) Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°) SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? N/A (ft) Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☒yes ☐no
If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☒Omni Directional

How high (ft) is the microphone above ground level? 10 (ft) Compliance = 10 feet

Are calls recorded in :
☒ Full Spectrum
☐ Zero Crossing

3. Is the gear working? ☒yes ☐no — Checked by (name) Robert Jean at 1:00pm (Time)

4. Is detector water-proofed? ☒Yes ☐No _____Initial

5. What is the temperature 91 (°F)? Compliance= >50 degrees F

What is the wind speed (mph) 8 ? Compliance = <9 mph sustained

_____ Precipitation for 30 minutes straight or intermittent the first 5 hours

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue, Cincinnati, OH 45232 (Phone: 513-451-1777)

HABITAT ASSESSMENT

Project #: 1562 Date: 10-Jul-2020 State: IN County: Jackson

Project Name: IFA Bees & Bats Site Name/#: 1562-AS-009 USGS Quad:

Permitted Biologist: Robert Jean (full name) Other Field Staff: Michelle (full name) State Permit #:

Federal Permit #:

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude		Longitude		Picture #	Waypoint #
	SM400912	39.001069	°N	-86.259418	°W	Ipad	Ipad
			°N		°W		
			°N		°W		
			°N		°W		
			°N		°W		

Distance to closest water source (meters): 29 Type of water source: pond

Water source name: Unnamed

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____meters Channel Width: _____meters Stream Width: _____meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ____m or cm Clarity (H,M,L):____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)

Ash

Eastern Red Cedar

White Oak

Subdominant Canopy Species (< 40 cm/16" dbh)

Cornus

Red Maple

Staghorn Sumac

Estimated dbh range: Lg: 20-30 Sm: 16-20 Estimated dbh range: Lg: 5-10 Sm: 1-5

Relative abundance of dominant vs. subdominant (ratio): 1:5

Estimated canopy closure: ___Closed X Moderate ___Open

Roost tree potential consists of: ___Hollow ___Large Trees ___Snags X Neither

M. sodalis roost tree potential is: ___High ___Moderate X Low

Roost potential comments: Forested area about 25-30yrs old

M. septentrionalis roost tree potential is: ___High ___Moderate X Low

Roost potential comments: Forested area about 25-30yrs old

Subcanopy clutter: ___Closed X Moderate ___Open

Subcanopy consists largely of: ___ Lower Branches of Canopy Trees X Saplings ___Shrubs

Common Subcanopy Species: Sumac W. oak R. Maple

Check all that apply:

__Mature Upland Forest X Recently Logged Forest __Crop/Pasture Land Other Pond

__Young Upland Forest X Forest Edge __Stream/River

__Mature Lowland Forest __Woodlot __Vernal Pool

__Young Lowland Forest X Old Field __Deepwater Lake/Pond

Herbaceous Cover: ___ Sparse ___Moderate X Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

Project #:	State/County:	Site Name/#:	Initials:

SKETCH NETS and/or DETECTORS

N

LEGEND

Net: ●——●

Detector: ▭◁

DETAILED HABITAT DESCRIPTION & COMMENTS

Open meadow area near small pond on edge of upland forest dom. by W. oak, ash, & eastern red cedar. Vegetation in opening w many small sumac, forbs & grass

2020

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: 10-Jul-2020

Project Name: IFA Bees & Bat Site Name#: 1562-AS-0009 301-2

State: IN County: Jackson

GPS Unit#: Camera/IPAD #:

Biologist (Full name) selected site Robert Jean

Biologist (Full name) deployed detector Robert Jean

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
(4-7)	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET 12'22

Detector # Red Tag	301-2 Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
SM400912	39.001069 °N	-86.259418 °W	20:42	6:59	Ipad	Ipad	Ipad

Provide: Information about the Detector & Microphone

___ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)
___ SM 3 (___U1 or ___U2 micropone), ___ SM 4 (U2) X Mini (U2)_

___ Titley Electronics Anabat (AB): ___ SD 1, ___ SD2, ___ ABII and ZCAIM
Microphone Type ___ Standard (Black) ___ High (Green) or ___ Stainless steel_

Detector Placement/Site Description:

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 10 (ft)
Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 2,050 (ft)
Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? 100 (ft)
Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°)
SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? 6 x Kng (ft) W ^
Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☒ yes ☐ no
If not, WHY?

2. Is the Microphone? ☐ Directional ☐ Hemispherical ☒ Omni Directional

How high (ft) is the microphone above ground level? 10 (ft)
Compliance = 10 feet

Are calls recorded in :
☒ Full Spectrum
☐ Zero Crossing

3. Is the gear working? ☒ yes ☐ no

Checked by (name) Rob Jean at 12:26 (Time)

4. Is detector water-proofed? X Yes ☐ No

5. What is the temperature 90 (°F)?
Compliance= >50 degrees F

What is the wind speed (mph) 5 ?
Compliance = <9 mph sustained

___ Initial

___ Precipitation for 30 minutes straight or intermittent the first 5 hours

Revised May 2020

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue, Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT

Project #: 1562 **Date:** 10 June 2020 **State:** IN **County:** Jackson

Project Name: INFA Bats-Bees **Site Name/#:** 1562-NS-010 **USGS Quad:** Owl

Permitted Biologist: Michael Mainer (full name) Other Field Staff: _____ (full name) State Permit #: _____ Federal Permit #: _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
D	SMU07144	39.012956887 °N	-86.264777778 °W	DAD	WPAD
		°N	°W		
		°N	°W		
		°N	°W		

Distance to closest water source (meters): 350 Type of water source: Pond

Water source name: N/A

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____ meters Channel Width: _____ meters Stream Width: _____ meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ____m or cm Clarity (H,M,L): ____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)	Subdominant Canopy Species (< 40 cm/16" dbh)
Pinus sertina	Fraxinus sp.
Quercus alba	Cornus florida
Juglans nigra	Juniperus virginiana

Estimated dbh range: Lg: 100 Sm: 40 Estimated dbh range: Lg: 39 Sm: 20

Relative abundance of dominant vs. subdominant (ratio): 1:20

Estimated canopy closure: ___Closed ___Moderate X Open

Roost tree potential consists of: ___Hollow X Large Trees ___Snags ___ Neither

M. sodalis roost tree potential is: ___High X Moderate ___Low

Roost potential comments: Roosting options but nothing great

M. septentrionalis roost tree potential is: ___High X Moderate ___Low

Roost potential comments: Roosting options but nothing great.

Subcanopy clutter: ___Closed ___Moderate X Open

Subcanopy consists largely of: ___ Lower Branches of Canopy Trees ___Saplings ___Shrubs

Common Subcanopy Species: Rubus sp. Solidago sp. Asclepias sp.

Check all that apply:

X Mature Upland Forest	__Recently Logged Forest	__Crop/Pasture Land	Other _____
__Young Upland Forest	X Forest Edge	__Stream/River	_____
__Mature Lowland Forest	__Woodlot	__Vernal Pool	_____
__Young Lowland Forest	X Old Field	__Deepwater Lake/Pond	_____

Herbaceous Cover: ___ Sparse ___Moderate X Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

Project #: 1562	State/County: Indiana / Jackson	Site Name/#: 1562-AS-00	Initials: MLM

SKETCH NETS and/or DETECTORS

N

LEGEND

Net:

Detector:

DETAILED HABITAT DESCRIPTION & COMMENTS

Maintained forest opening / meadow in upland forest.

ESI

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: 07 July 2020

Project Name: INFA Bats+Bees Site Name#: 1562-AS-010

State: IN County: Jackson

GPS Unit#: IPAD Camera/IPAD #: IPAD

Biologist (Full name) selected site Michael Monroe

Biologist (Full name) deployed detector

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
S4007144	39.01295587°N	-86.26477778°W	2040	0700	IPAD	IPAD	IPAD

Provide: Information about the Detector & Microphone

___ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)

___SM 3 (___U1 or ___U2 micropone), X SM 4 (U2) ____ Mini (U2)_

___ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ___ABII and ZCAIM

Microphone Type_____Standard (Black) ___ High (Green) or ___Stainless steel_

Detector Placement/Site Description: forested edge of meadow.

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 10 (ft)
Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 700 (ft)
Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? 70 (ft)
Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°)
SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? 70 (ft)
Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☒yes ☐no
If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☒Omni Directional

How high (ft) is the microphone above ground level? 10 (ft)
Compliance = 10 feet

Are calls recorded in :
☒ Full Spectrum
☐ Zero Crossing

3. Is the gear working? ☒yes ☐no

Checked by (name) Monroe at 1640 (Time)

4. Is detector water-proofed? ☒Yes ☐No MLM Initial

5. What is the temperature____ (°F)?
Compliance= >50 degrees F

What is the wind speed (mph)____?
Compliance = <9 mph sustained

____ Precipitation for 30 minutes straight or intermittent the first 5 hours

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue, Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT

Project #: 1562 **Date:** 10 July 2020 **State:** IN **County:** Jackson

Project Name: INFA Bees + Bats **Site Name/#:** 1562-AS-011 **USGS Quad:** Ouk

Permitted Biologist: Michael Mallory (full name) Other Field Staff: _____ (full name) State Permit #: _____ Federal Permit #: _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
D	5400058	39.013051 81 °N	-86.262635 54 °W	IMG	IMG
		° ' "N	° ' "W		
		° ' "N	° ' "W		
		° ' "N	° ' "W		

Distance to closest water source (meters): 350 Type of water source: Pond

Water source name: Unknown

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____meters Channel Width: _____meters Stream Width: _____meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ____m or cm Clarity (H,M,L): _____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)	Subdominant Canopy Species (< 40 cm/16" dbh)
Quercus alba	Cornus florida
Acer saccharum	Sassafras alba
Liriodendron tulipifera	Juniperus virginia

Estimated dbh range: Lg: 60 Sm: 40 Estimated dbh range: Lg: 39 Sm: 10

Relative abundance of dominant vs. subdominant (ratio): 1:1 2:1

Estimated canopy closure: ___Closed X Moderate ___Open

Roost tree potential consists of: ___Hollow X Large Trees X Snags ___ Neither

M. sodalis roost tree potential is: ___High X Moderate ___Low

Roost potential comments: Roosting potential but not excellent

M. septentrionalis roost tree potential is: ___High X Moderate ___Low

Roost potential comments: Roosting potential but no excellent

Subcanopy clutter: ___Closed X Moderate ___Open

Subcanopy consists largely of: ___Lower Branches of Canopy Trees X Saplings X Shrubs

Common Subcanopy Species: Ribes sp. Fraxinus sp. Solidago sp.

Check all that apply:

X Mature Upland Forest	___Recently Logged Forest	___Crop/Pasture Land	Other _____
___Young Upland Forest	X Forest Edge	___Stream/River	_____
___Mature Lowland Forest	___Woodlot	___Vernal Pool	_____
___Young Lowland Forest	X Old Field	___Deepwater Lake/Pond	_____

Herbaceous Cover: ___ Sparse ___Moderate X Dense

2020

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

Project #: 1862	State/County: JW/Jackson	Site Name/#: AS-011	Initials: MM

SKETCH NETS and/or DETECTORS

N

LEGEND

Net:

Detector:

DETAILED HABITAT DESCRIPTION & COMMENTS

Upland maintained meadow
bounded by large forest area.

2020

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: 7th July 2020

Project Name: INFA Bats+Bees Site Name#: 1562-AS-011

State: IN County: Jackson

GPS Unit#: IPAD Camera/IPAD #: IPAD

Biologist (Full name) selected site Michael Monroe

Biologist (Full name) deployed detector

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
5400058	39.013051 81 °N	-86.262635 5 W	2040	0700	IPAD	IPAD	IPAD

Provide: Information about the Detector & Microphone

___ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)	___ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ___ABII and ZCAIM
___SM 3 (___U1 or ___U2 micropone), X SM 4 (U2) ___ Mini (U2)_	Microphone Type___Standard (Black) ___ High (Green) or ___Stainless steel_

Detector Placement/Site Description: (Wooded edge at treeline).

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 10 (ft) Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 700 (ft) Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? 300 (ft) Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°) SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? 61 (ft) Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☒yes ☐no If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☒Omni Directional

How high (ft) is the microphone above ground level? 10 (ft) Compliance = 10 feet

Are calls recorded in : ☐ Full Spectrum ☒ Zero Crossing

3. Is the gear working? ☒yes ☐no

Checked by (name) Monroe at 1600 (Time)

4. Is detector water-proofed? ☒Yes ☐No MM Initial

5. What is the temperature___ (°F)? Compliance= >50 degrees F

What is the wind speed (mph)___? Compliance = <9 mph sustained

___ Precipitation for 30 minutes straight or intermittent the first 5 hours

Revised May 2020

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

HABITAT ASSESSMENT

Project #: 1562 Date: 10-Jul-2020 State: IN County: Jackson

Project Name: IFA Site Name/#: 1562-AS-012 USGS Quad: _____

Permitted Biologist: Robert Jean (full name) Other Field Staff: Michelle Jean (full name) State Permit #: _____

Federal Permit #: _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
	SM400956	38.973098 °N	-86.263345 °W	Ipad	Ipad
		°N	°W		
		°N	°W		
		°N	°W		
		°N	°W		

Distance to closest water source (meters): 15 Type of water source: Pond

Water source name: Unnamed pond

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____meters Channel Width: _____meters Stream Width: _____meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ____m or cm Clarity (H,M,L):____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)

Tulip
Bigtooth Aspen
White Pine

Subdominant Canopy Species (< 40 cm/16" dbh)

Ash
Tulip
White Pine

Estimated dbh range: Lg: 25-40 Sm: 16-24 Estimated dbh range: Lg: 4-16 Sm: 0-4

Relative abundance of dominant vs. subdominant (ratio): 5:1

Estimated canopy closure: ___Closed X Moderate ___Open

Roost tree potential consists of: ___Hollow X Large Trees ___Snags ___ Neither

M. sodalis roost tree potential is: ___High X Moderate ___Low

Roost potential comments: Some sloughing back on more mature trees

M. septentrionalis roost tree potential is: ___High ___Moderate X Low

Roost potential comments: Few trees with openings or cavities

Subcanopy clutter: ___Closed X Moderate ___Open

Subcanopy consists largely of: ___ Lower Branches of Canopy Trees X Saplings ___Shrubs

Common Subcanopy Species: Ash Tulip Oak

Check all that apply:

X Mature Upland Forest
X Young Upland Forest
__Mature Lowland Forest
__Young Lowland Forest
__Recently Logged Forest
X Forest Edge
__Woodlot
X Old Field
__Crop/Pasture Land
__Stream/River
__Vernal Pool
__Deepwater Lake/Pond
Other _____

Herbaceous Cover: ___ Sparse ___Moderate X Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue, Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

Project #:	State/County:	Site Name/#:	Initials:

SKETCH NETS and/or DETECTORS

N

LEGEND

Net: ●——●

Detector: ▭◁

DETAILED HABITAT DESCRIPTION & COMMENTS

Small wildlife opening w small pond in middle of mature forest dominated by tulip, white pine, + red oaks. Small trees mainly tulip, ash, cedar, & white pine. Herbaceous w/ many forbs & some grasses - woodland w/ many shrubs & less herbaceous layer

2020

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: 10-Jul-2020
Project Name: IFA Bees&Bats Site Name#: 1562-AS-012
State: IN County: Jackson
GPS Unit#: Camera/IPAD #:
Biologist (Full name) selected site Robert Jean
Biologist (Full name) deployed detector Robert Jean

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
(8-12)	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET 4:50/16:51

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
SMH00956	38.973098 "N	-86.263345 "W	20:42	6:59	Ipad	Ipad	Ipad

Provide: Information about the Detector & Microphone

___ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)
____SM 3 (___U1 or ___U2 micropone), ____SM 4 (U2) X Mini (U2)_

___ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ___ABII and ZCAIM
Microphone Type____Standard (Black) ___ High (Green) or ___Stainless steel_

Detector Placement/Site Description:

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 10 (ft)
Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 7,273 / 2656 (ft)
Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? >33 (ft)
Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°)
SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? N/A (ft)
Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☒yes ☐no
If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☒Omni Directional

How high (ft) is the microphone above ground level? 10 (ft)
Compliance = 10 feet

Are calls recorded in :
☒ Full Spectrum
☐ Zero Crossing

3. Is the gear working? ☒yes ☐no

Checked by (name) Robert Jean at 4:50 (Time)

4. Is detector water-proofed? ☒Yes ☐No _____Initial

5. What is the temperature 87.5 (F)?
Compliance= >50 degrees F

What is the wind speed (mph) 8 ?
Compliance = <9 mph sustained

_____ Precipitation for 30 minutes straight or intermittent the first 5 hours

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

HABITAT ASSESSMENT

Project #: 1562 **Date:** July 10, 2020 **State:** IN **County:** Jackson

Project Name: IFA Pads **Site Name/#:** 1562-AS-013 **USGS Quad:** Unk

Permitted Biologist: P. Recher Jared K (full name) Other Field Staff: _____ (full name) State Permit #: _____ Federal Permit #: _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
1562-AS-013	SMU00750	38.99762796 °N	-86.20784910 °W		
		°N	°W		
		°N	°W		
		°N	°W		

Distance to closest water source (meters): 1460 Type of water source: Pond

Water source name: N/A

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____meters Channel Width: _____meters Stream Width: _____meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ____m or cm Clarity (H,M,L): ____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)
Quercus montana

Subdominant Canopy Species (< 40 cm/16" dbh)
Sassafras albidum
Quercus rubra

Estimated dbh range: Lg: 25 Sm: 20

Estimated dbh range: Lg: 15 Sm: 10

Relative abundance of dominant vs. subdominant (ratio): 1:3

Estimated canopy closure: ___Closed ___Moderate ✓Open

Roost tree potential consists of: ___Hollow ✓Large Trees ___Snags ___ Neither

M. sodalis roost tree potential is: ___High ✓Moderate ___Low

Roost potential comments: Few snags with proper light exposure

M. septentrionalis roost tree potential is: ___High ✓Moderate ___Low

Roost potential comments: Few snags with proper light exposure

Subcanopy clutter: ___Closed ✓Moderate ___Open

Subcanopy consists largely of: ✓ Lower Branches of Canopy Trees ✓Saplings ___Shrubs

Common Subcanopy Species: Sassafras albidum Quercus rubra

Check all that apply:

__Mature Upland Forest
✓Young Upland Forest
__Mature Lowland Forest
__Young Lowland Forest
__Recently Logged Forest
__Forest Edge
__Woodlot
__Old Field
__Crop/Pasture Land
__Stream/River
__Vernal Pool
__Deepwater Lake/Pond
Other Pipeline ROW

Herbaceous Cover: ___ Sparse ___Moderate ✓Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

Project #:	State/County:	Site Name/#:	Initials:

SKETCH NETS and/or DETECTORS

N

LEGEND	DETAILED HABITAT DESCRIPTION & COMMENTS
Net: ●——● Detector: ▭◁	Detector placed along Pipline R.O.W. Pipline R.O.W goes through young upland forest with few snags sparcly scattered throughout.

2020

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: July 10, 2020

Project Name: FA Bats Site Name#: 1562-AS-013

State: Indiana County: Jackson

GPS Unit#: SM100750 Camera/IPAD #: 425

Biologist (Full name) selected site _____

Biologist (Full name) deployed detector _____

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
	38.99762796 °N	-86.20748910 °W	20:42	6:59	IPAD		

Provide: Information about the Detector & Microphone

___ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)
___SM 3 (___U1 or ___U2 micropone), ___SM 4 (U2) ___(Mini (U2)_)

___ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ___ABII and ZCAIM
Microphone Type____Standard (Black) ___ High (Green) or ___Stainless steel_

Detector Placement/Site Description: _____

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 15 (ft)
Compliance = 10 feet minimum

How far (ft) is the detector from another detector? _____(ft)
Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? 3.20 (ft)
Compliance = 33 feet minimum

What is the angle of the microphone? 0 (◦)
SM should be horizontal, AB ~45◦

How far (ft) is the detector from any potential or known roost? ? (ft)
Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☑yes ☐no
If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☑Omni Directional

How high (ft) is the microphone above ground level? 10 (ft)
Compliance = 10 feet

Are calls recorded in :
☑ Full Spectrum
☐ Zero Crossing

3. Is the gear working? ☑yes ☐no

Checked by (name) Jared K at 15:20 (Time)

4. Is detector water-proofed? ☑Yes ☐No JK Initial

5. What is the temperature 82? (◦F)?
Compliance= >50 degrees F

What is the wind speed (mph) 1-2?
Compliance = <9 mph sustained

_____ Precipitation for 30 minutes straight or intermittent the first 5 hours

Revised May 2020

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue, Cincinnati, OH 45232 (Phone: 513-451-1777)

HABITAT ASSESSMENT

Project #: 1562 Date: July 10, 2020 State: IN County: Jackson

Project Name: IFA Bats Site Name/#: 1562-AS-014 USGS Quad: Unk

Permitted Biologist: Paige R Jaked K (full name) Other Field Staff: _____ (full name) State Permit #: _____ Federal Permit #: _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
1562-AS-014	SMU00315	39.012355 °N	-86.204336 °W	IP4D	
		°N	°W		
		°N	°W		
		°N	°W		

Distance to closest water source (meters): 260 Type of water source: pond

Water source name: N/A

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____meters Channel Width: _____meters Stream Width: _____meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ____m or cm Clarity (H,M,L):____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)
Acer saccarum

Subdominant Canopy Species (< 40 cm/16" dbh)
Pinus strobus
Populus occidentalis
Platanous occidentalis

Estimated dbh range: Lg: 22 Sm: 18 Estimated dbh range: Lg: 10 Sm: 15

Relative abundance of dominant vs. subdominant (ratio): 1:5

Estimated canopy closure: ___Closed ✓Moderate ___Open

Roost tree potential consists of: ___Hollow ✓Large Trees ___Snags ___ Neither

M. sodalis roost tree potential is: ___High ___Moderate ✓Low

Roost potential comments: Clearing inside woodlot lacking snags and hollows

M. septentrionalis roost tree potential is: ___High ✓Moderate ___Low

Roost potential comments: Clearing inside woodlot lacking snags and hollows

Subcanopy clutter: ___Closed ✓Moderate ___Open

Subcanopy consists largely of: ✓Lower Branches of Canopy Trees ✓Saplings ___Shrubs

Common Subcanopy Species: Pinus strobus Populus occidentalis Platanous oxydentalis

Check all that apply:

__Mature Upland Forest	__Recently Logged Forest	__Crop/Pasture Land	Other _____
✓Young Upland Forest	__Forest Edge	__Stream/River	_____
__Mature Lowland Forest	✓Woodlot	__Vernal Pool	_____
__Young Lowland Forest	__Old Field	__Deepwater Lake/Pond	_____

Herbaceous Cover: ___ Sparse ✓Moderate ___Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue, Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

Project #:	State/County:	Site Name/#:	Initials:

SKETCH NETS and/or DETECTORS

N

LEGEND	DETAILED HABITAT DESCRIPTION & COMMENTS
Net: ●——●	Clearing within young upland forest adjacent to crop land. Clearing consists of mostly subdomanent trees with few snags suitable for long term roosting.
Detector: ▭◁	

2020

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: July 10, 2020
Project Name: IFA Bats Site Name#: 1562-AS-014
State: SMU00878 County: Jackson
GPS Unit#: IPAD Camera/IPAD#: 425
Biologist (Full name) selected site
Biologist (Full name) deployed detector: Paige R Jared K

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
1562-AS-01	39.012355 09 "N	86:20433601"W	20:42	6:59	IPAD		

Provide: Information about the Detector & Microphone

___ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)
____SM 3 (___U1 or ___U2 micropone), ____SM 4 (U2) ____Mini (U2)_

___ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ____ABII and ZCAIM
Microphone Type____Standard (Black) ___ High (Green) or ___Stainless steel_

Detector Placement/Site Description:

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 15 (ft)
Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 656 (ft)
Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? 100 (ft)
Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°)
SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? 50 (ft)
Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☐yes ☑no
If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☑Omni Directional

How high (ft) is the microphone above ground level? 10 (ft)
Compliance = 10 feet

Are calls recorded in :
☑ Full Spectrum
☑ Zero Crossing

3. Is the gear working? ☑yes ☐no — Checked by (name) Jared K at _____(Time)

4. Is detector water-proofed? ☑Yes ☐No — JK Initial

5. What is the temperature 67.2°F)?
Compliance= >50 degrees F

What is the wind speed (mph) 1.4?
Compliance = <9 mph sustained

____ Precipitation for 30 minutes straight or intermittent the first 5 hours

Revised May 2020

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

HABITAT ASSESSMENT

Project #: 1502 **Date:** July 10, 2020 **State:** IN **County:** Jackson

Project Name: IFA Bats **Site Name/#:** 1502-AS-015 **USGS Quad:** _____

Permitted Biologist: Jared K, P Reecher (full name) Other Field Staff: _____ (full name) State Permit #: _____ Federal Permit #: _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
1502-AS-015	SMU00779	39.012357 °N	-86.207205 °W		
		°N	°W		
		°N	°W		
		°N	°W		

Distance to closest water source (meters): 50m Type of water source: Pond

Water source name: n/a

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____meters Channel Width: _____meters Stream Width: _____meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ____m or cm Clarity (H,M,L):___

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)	Subdominant Canopy Species (< 40 cm/16" dbh)
Quercus Montana	Juglans nigra
Quercus rubra	Pinus Strobus
	Liriodendron tulipifera

Estimated dbh range: Lg: 25 Sm: 20 Estimated dbh range: Lg: 15 Sm: 10

Relative abundance of dominant vs. subdominant (ratio): 1:10

Estimated canopy closure: ___Closed ✓Moderate ___Open

Roost tree potential consists of: ___Hollow ✓Large Trees ✓Snags ___ Neither

M. sodalis roost tree potential is: ___High ✓Moderate ___Low

Roost potential comments: Few snags with minimal light exposure.

M. septentrionalis roost tree potential is: ___High ✓Moderate ___Low

Roost potential comments: Few snags with minimal light exposure.

Subcanopy clutter: ___Closed ✓Moderate ___Open

Subcanopy consists largely of: ✓ Lower Branches of Canopy Trees ✓Saplings ✓Shrubs

Common Subcanopy Species: Pinus strobus Juglans nigra Liriodendron tulipifera

Check all that apply:

__Mature Upland Forest	__Recently Logged Forest	__Crop/Pasture Land	Other _____
✓Young Upland Forest	✓Forest Edge	__Stream/River	_____
__Mature Lowland Forest	__Woodlot	__Vernal Pool	_____
__Young Lowland Forest	__Old Field	✓Deepwater Lake/Pond	_____

Herbaceous Cover: ___ Sparse ✓Moderate ___Dense

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

Project #:	State/County:	Site Name/#:	Initials:

SKETCH NETS and/or DETECTORS

N

LEGEND	DETAILED HABITAT DESCRIPTION & COMMENTS
Net: ●——●	Small clearing with pond South of the detector. Clearing is contained within a young woland forest with few snags surrounding pond.
Detector: ▭◁	

2020

ESI

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: July 10, 2020
Project Name: IFA Bats Site Name#: 1562-AS-015
State: Indiana County: Jackson
GPS Unit#: IPAD Camera/IPAD #: 425
Biologist (Full name) selected site
Biologist (Full name) deployed detector: Paige R Jared K

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
SMU00779	39.012527022 °N	-86.207856099 °W	2042	6:59	IPAD		

Provide: Information about the Detector & Microphone

___ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)
___SM 3 (___U1 or ___U2 micropone), ___SM 4 (U2) ___ Mini (U2)_

___ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ___ABII and ZCAIM
Microphone Type____Standard (Black) ___ High (Green) or ___Stainless steel_

Detector Placement/Site Description:

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 20 (ft)
Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 600 (ft)
Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? 200 (ft)
Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°)
SM should be horizontal, AB ~45°

Is the detector Parallel to woodland? ☐yes ☒no
If not, WHY?

How far (ft) is the detector from any potential or known roost? ? (ft)
Compliance = 50 feet minimum

2. Is the Microphone? ☐Directional ☐ Hemispherical ☒Omni Directional

How high (ft) is the microphone above ground level? 10 (ft)
Compliance = 10 feet

Are calls recorded in :
☒Full Spectrum
☐ Zero Crossing

3. Is the gear working? ☒yes ☐no — Checked by (name) Jared K at 14:30 (Time)

4. Is detector water-proofed? ☒Yes ☐No — JK Initial

5. What is the temperature 66.2 (°F)?
Compliance= >50 degrees F

What is the wind speed (mph) 3.1 ?
Compliance = <9 mph sustained

____ Precipitation for 30 minutes straight or intermittent the first 5 hours

Revised May 2020

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue, Cincinnati, OH 45232 (Phone: 513-451-1777)

HABITAT ASSESSMENT

Project #: 1562 **Date:** July 10, 2020 **State:** IN **County:** Jackson

Project Name: IFA Bats **Site Name/#:** 1562-AS-016 **USGS Quad:** Unk

Permitted Biologist: Paige R Tarvedy (full name) Other Field Staff: _____ (full name) State Permit #: _____ Federal Permit #: _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
1562-AS-016	SM4[illegible]865	39.011945°N	-86.206675°W		
		°N	°W		
		°N	°W		
		°N	°W		

Distance to closest water source (meters): 646 Type of water source: Pond

Water source name: N/A

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____meters Channel Width: _____meters Stream Width: _____meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ____m or cm Clarity (H,M,L): ____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)

Subdominant Canopy Species (< 40 cm/16" dbh)
Platanus occidentalis
Juglans nigra
Pinus strobus

Estimated dbh range: Lg: _____ Sm: _____ Estimated dbh range: Lg: 15 Sm: 10

Relative abundance of dominant vs. subdominant (ratio): 0:1

Estimated canopy closure: ___Closed ✓Moderate ___Open

Roost tree potential consists of: ___Hollow ✓Large Trees ___Snags ___ Neither

M. sodalis roost tree potential is: ___High ___Moderate ✓Low

Roost potential comments: Few large trees with exfoliating bark and light exposure

M. septentrionalis roost tree potential is: ___High ✓Moderate ___Low

Roost potential comments: Few large trees with exfoliating bark and light exposure.

Subcanopy clutter: ___Closed ✓Moderate ___Open

Subcanopy consists largely of: ✓ Lower Branches of Canopy Trees ✓Saplings ✓Shrubs

Common Subcanopy Species: Platinous occidentalis Juglans nigra Pinus strobus

Check all that apply:

__Mature Upland Forest
✓Young Upland Forest
__Mature Lowland Forest
__Young Lowland Forest
__Recently Logged Forest
✓Forest Edge
✓Woodlot
__Old Field
✓Crop/Pasture Land
__Stream/River
__Vernal Pool
__Deepwater Lake/Pond
Other _____

Herbaceous Cover: ___ Sparse ✓Moderate ___Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

Project #:	State/County:	Site Name/#:	Initials:

SKETCH NETS and/or DETECTORS

N

LEGEND	DETAILED HABITAT DESCRIPTION & COMMENTS
Net: ●——●	Detector placed along woodlot edge parallel to a crop field. Woodlot consits of mostly subdominant upland trees.
Detector: ▭◁	

2020

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: 7 July 2020

Project Name: IFA Bees & Site Name#: 1562-AS-010

State: TN County: Jackson

GPS Unit#: IPAD Camera/IPAD #: IPAD

Biologist (Full name) selected site

Biologist (Full name) deployed detector Paige Reeher Jared K

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET

10hrs 17mins

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
	39.617950 "N	-86.206675 "W	20:42	6:59	IPAD		

Provide: Information about the Detector & Microphone

___ Wildlife Acoustcs Songmeter (SM): Please pick and model (~~microphone~~)

___SM 3 (___U1 or ___U2 micropone), ___SM 4 (U2) ___(Mini (U2)_

___ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ___ABII and ZCAIM

Microphone Type___Standard (Black) ___ High (Green) or ___Stainless steel_

Detector Placement/Site Description:

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 15 (ft)
Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 2140 (ft)
Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? 200 (ft)
Compliance = 33 feet minimum

What is the angle of the microphone? ∅ (°)
SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? 50 (ft)
Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☐yes ☑no
If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☑Omni Directional

How high (ft) is the microphone above ground level? 10 (ft)
Compliance = 10 feet

Are calls recorded in :
☑ Full Spectrum
☐ Zero Crossing

3. Is the gear working? ☑yes ☐no

Checked by (name) Jared K at 11:20 (Time)

4. Is detector water-proofed? ☑Yes ☐No JK Initial

5. What is the temperature 76.4 (°F)?
Compliance= >50 degrees F

What is the wind speed (mph) 2.3?
Compliance = <9 mph sustained

___ Precipitation for 30 minutes straight or intermittent the first 5 hours

Revised May 2020

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

HABITAT ASSESSMENT

Project #: 1562 Date: 10-Jul-2020 State: IN County: Jackson

Project Name: IFA - Bees & Bats Site Name/#: 1562-AS-018 USGS Quad: _____

Permitted Biologist: Robert Jean (full name) Other Field Staff: Michelle Jean (full name) State Permit #: _____

Federal Permit #: _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
D	1562-AS-018	39.017324 °N	-86.232731 °W	Ipad	Ipad
		°N	°W		
		°N	°W		
		°N	°W		

Distance to closest water source (meters): 1674 Type of water source: Wetland

Water source name: Unknown

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____meters Channel Width: _____meters Stream Width: _____meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ____m or cm Clarity (H,M,L):____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)

Sycamore
River Birch
Red Maple

Subdominant Canopy Species (< 40 cm/16" dbh)

Sweet Gum
Red Maple
Tulip

Estimated dbh range: Lg: 20-30 Sm: 16-20 Estimated dbh range: Lg: 4-10 Sm: 0-4

Relative abundance of dominant vs. subdominant (ratio): 1:10

Estimated canopy closure: ___Closed X Moderate ___Open

Roost tree potential consists of: X Hollow ___Large Trees X Snags ___ Neither

M. sodalis roost tree potential is: ___High X Moderate ___Low

Roost potential comments: Sloughing bark on many birch

M. septentrionalis roost tree potential is: ___High X Moderate ___Low

Roost potential comments: A few hollows in Sycamores - decent solar exposure

Subcanopy clutter: ___Closed X Moderate ___Open

Subcanopy consists largely of: ___ Lower Branches of Canopy Trees X Saplings ___Shrubs

Common Subcanopy Species: Sweet gum Red Maple _____

Check all that apply:

__Mature Upland Forest
__Young Upland Forest
__Mature Lowland Forest
X Young Lowland Forest
__Recently Logged Forest
X Forest Edge
__Woodlot
X Old Field
__Crop/Pasture Land
__Stream/River
__Vernal Pool
__Deepwater Lake/Pond
Other _____

Herbaceous Cover: ___ Sparse ___Moderate X Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

Project #:	State/County:	Site Name/#:	Initials:

SKETCH NETS and/or DETECTORS

LEGEND

Net: ●——●

Detector: ▭◁

DETAILED HABITAT DESCRIPTION & COMMENTS

Open field dominated by grasses & forbs on edge of wet forest with red maple, sycamore, tulip, and many asters in forest floor

2020

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: 10-Jul-2020
Project Name: IFA-Bees&Bats Site Name#: 1562-AS-018
State: IN County: Jackson
GPS Unit#: Camera/IPAD #:
Biologist (Full name) selected site Robert Jean
Biologist (Full name) deployed detector Robert Jean

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
(1-3)	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

11:35
11:16

FILL IN THE FOLLOWING FOR EACH DETECTOR SET

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
SM400864	39 ; 017324 "N	-86 ; 232731 "W	10:42	06:20	Ipad	Ipad	Ipad

Provide: Information about the Detector & Microphone

____ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)	____ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ____ABII and ZCAIM
_____SM 3 (___U1 or ___U2 micropone), ____SM 4 (U2) X Mini (U2)_	Microphone Type_____Standard (Black) ___ High (Green) or ___Stainless steel_

Detector Placement/Site Description:

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 10 (ft) Compliance = 10 feet minimum

How far (ft) is the detector from another detector? > 656 (ft) Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? > 33 (ft) Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°) SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? ___ (ft) Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☒yes ☐no
If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☒Omni Directional

How high (ft) is the microphone above ground level? 10 (ft) Compliance = 10 feet

Are calls recorded in :
☒Full Spectrum
☐ Zero Crossing

3. Is the gear working? ☒yes ☐no — Checked by (name) Rob Jean at 11:30 (Time)

4. Is detector water-proofed? ☒Yes ☐No _____Initial

5. What is the temperature 93 (°F)? Compliance= >50 degrees F

What is the wind speed (mph) 1.0? Compliance = <9 mph sustained

_____ Precipitation for 30 minutes straight or intermittent the first 5 hours

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT

Project #: 1562 **Date:** 10 July 2020 **State:** IN **County:** Jackson

Project Name: INFA Bats/Bees **Site Name/#:** 1562-AS-020 **USGS Quad:** Uniontown

Permitted Biologist: Michael Monroe (full name) Other Field Staff: _____ (full name) State Permit #: _____ Federal Permit #: _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
D	SMU00863	39.011186 1/8 °N	-86.247473 1/6 °W	DPAD	DPAD
		°N	°W		
		°N	°W		
		°N	°W		

Distance to closest water source (meters): 0 Type of water source: Swamp

Water source name: Unknown

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: 0.25 meters Channel Width: 20 meters Stream Width: 15 meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand X Silt/Clay Swamp

Still Water Present (Y/N): Y Average Water Depth: .5 m/or cm Clarity (H,M,L): L

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)	Subdominant Canopy Species (< 40 cm/16" dbh)
	Betula alleghaniensis
	Acer negundo
	Acer rubrum

Estimated dbh range: Lg: N/A Sm: N/A Estimated dbh range: Lg: 40 Sm: 8

Relative abundance of dominant vs. subdominant (ratio): N/A

Estimated canopy closure: ___Closed ___Moderate X Open

Roost tree potential consists of: ___Hollow ___Large Trees X Snags ___ Neither

M. sodalis roost tree potential is: X High ___Moderate ___Low

Roost potential comments: Snags in Swamp/great

M. septentrionalis roost tree potential is: X High ___Moderate ___Low

Roost potential comments: Snags in Swamp/great

Subcanopy clutter: ___Closed X Moderate ___Open

Subcanopy consists largely of: ___ Lower Branches of Canopy Trees X Saplings X Shrubs

Common Subcanopy Species: Acer Negundo Betula alleghaniensis Nyssa sp.

Check all that apply:

__Mature Upland Forest __Recently Logged Forest __Crop/Pasture Land Other Swamp
__Young Upland Forest X Forest Edge X Stream/River
X Mature Lowland Forest __Woodlot __Vernal Pool
__Young Lowland Forest __Old Field __Deepwater Lake/Pond

Herbaceous Cover: ___ Sparse X Moderate ___Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

Project #:	State/County:	Site Name/#:	Initials:
56	IN/Jackson	MS-020	MM

SKETCH NETS and/or DETECTORS

N

LEGEND

Net:

Detector:

DETAILED HABITAT DESCRIPTION & COMMENTS

Swamp w/ forest surrounding. Swamp was formed due to stream / water c. beaver dam.

ESI

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: 10 July 2020

Project Name: INFABroadBand Site Name#: 1562-AS-020

State: IN County: Jackson

GPS Unit#: IPAD Camera/IPAD #: IPAD

Biologist (Full name) selected site Michael Marrese

Biologist (Full name) deployed detector

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	13-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
SMU00863	39.011186118 °N	-86.247473400	2040	07:00	IPAD	IPAD	

Provide: Information about the Detector & Microphone

___ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)	___ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ___ABII and ZCAIM
___SM 3 (___U1 or ___U2 micropone), ___SM 4 (U2) ___X Mini (U2)_	Microphone Type___Standard (Black) ___ High (Green) or ___Stainless steel_

Detector Placement/Site Description: Swamp along forested edge.

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 10 (ft)
Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 1000 (ft)
Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? 300 (ft)
Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°)
SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? 50 (ft)
Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☑yes ☐no
If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☑Omni Directional

How high (ft) is the microphone above ground level? 10 (ft)
Compliance = 10 feet

Are calls recorded in :
☑ Full Spectrum
☑Zero Crossing

3. Is the gear working? ☑yes ☐no

Checked by (name) Nate-E at 13:39 (Time)

4. Is detector water-proofed? ☑Yes ☐No MLM Initial

5. What is the temperature____ (°F)?
Compliance= >50 degrees F

What is the wind speed (mph)____?
Compliance = <9 mph sustained

____ Precipitation for 30 minutes straight or intermittent the first 5 hours

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT

Project #: 1962 **Date:** 10 July 2020 **State:** IN **County:** Jackson

Project Name: INFA Patch Tree **Site Name/#:** 562-AS-021 **USGS Quad:** Unk

Permitted Biologist: Michael Mercer (full name) Other Field Staff: _____ (full name) State Permit #: _____ Federal Permit #: _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
D	5400530	39.00890496 °N	-86.0330363 °W	IMAP	5440
		°N	°W		
		°N	°W		
		°N	°W		

Distance to closest water source (meters): 300 Type of water source: Pond

Water source name: Unk

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____meters Channel Width: _____meters Stream Width: _____meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ____m or cm Clarity (H,M,L): ____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)	Subdominant Canopy Species (< 40 cm/16" dbh)
Prunus serotina	Cornus florida
Pinus strobus	Acer negundo
Juglans nigra	Sassafras albidum

Estimated dbh range: Lg: 75 Sm: 40 Estimated dbh range: Lg: 39 Sm: 10

Relative abundance of dominant vs. subdominant (ratio): 12:1

Estimated canopy closure: X Closed ___Moderate ___Open

Roost tree potential consists of: ___Hollow X Large Trees X Snags ___ Neither

M. sodalis roost tree potential is: ___High X Moderate ___Low

Roost potential comments: Roosting habitat but nothing overly special

M. septentrionalis roost tree potential is: ___High X Moderate ___Low

Roost potential comments: Roosting habitat but nothing overly special

Subcanopy clutter: X Closed ___Moderate ___Open

Subcanopy consists largely of: X Lower Branches of Canopy Trees X Saplings ___Shrubs

Common Subcanopy Species: Acer negundo Cornus florida Rosa multiflora

Check all that apply:

X Mature Upland Forest	__Recently Logged Forest	__Crop/Pasture Land	Other ROW
__Young Upland Forest	X Forest Edge	__Stream/River	
__Mature Lowland Forest	__Woodlot	__Vernal Pool	
__Young Lowland Forest	__Old Field	__Deepwater Lake/Pond	

Herbaceous Cover: ___ Sparse X Moderate ___Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

HABITAT ASSESSMENT (continued)

Project #: 1562	State/County: IN/Jackson	Site Name/#: 1562-AS-01	Initials: MCM

SKETCH NETS and/or DETECTORS

N

LEGEND

Net: ●——●

Detector: ▭◁

DETAILED HABITAT DESCRIPTION & COMMENTS

forested ROW mat adjacents with forested road.

2020

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: 10 July 2020
Project Name: INFA Bees + Bats Site Name#: 1562-AS-021
State: IN County: Jackson
GPS Unit#: IOAD Camera/IPAD #: IPAD
Biologist (Full name) selected site Michael Mairose
Biologist (Full name) deployed detector

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
5400520	39.00290496°N	86.33303363°W	2040		IPAD	IPAD	IPAD

Provide: Information about the Detector & Microphone

\ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)	___ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ___ABII and ZCAIM
____SM 3 (___U1 or ___U2 micropone), ✓SM 4 (U2) ____ Mini (U2)_	Microphone Type____Standard (Black) ___ High (Green) or ___Stainless steel_

Detector Placement/Site Description: Along Forest Road (ROW)

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 10 (ft) Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 800 (ft) Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? 300 (ft) Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°) SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? 30 (ft) Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☒yes ☐no If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☒Omni Directional

How high (ft) is the microphone above ground level? 10 (ft) Compliance = 10 feet

Are calls recorded in : ☒ Full Spectrum ☒ Zero Crossing

3. Is the gear working? ☒yes ☐no — Checked by (name) Mairose at 12:00 (Time)

4. Is detector water-proofed? ☒Yes ☐No _____Initial

5. What is the temperature____ (°F)? Compliance= >50 degrees F

What is the wind speed (mph)____? Compliance = <9 mph sustained

____ Precipitation for 30 minutes straight or intermittent the first 5 hours

Revised May 2020

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue, Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT

Project #: ISG2 **Date:** 10 July 2020 **State:** IN **County:** Jackson

Project Name: INFA [illegible] **Site Name/#:** ISG2-MS-022 **USGS Quad:** Unk

Permitted Biologist: Michael [illegible] (full name) Other Field Staff: ________ (full name) State Permit #: ________

Federal Permit #: ________

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
Detector	54009161	39.0078084 °N	-86.2448806 °W	[illegible]	[illegible]
		°N	°W		
		°N	°W		
		°N	°W		

Distance to closest water source (meters): 5 Type of water source: Stream

Water source name: South Fork Salt Creek

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: ____ meters Channel Width: ____ meters Stream Width: ____ meters

Substratum: __ Bedrock __ Boulder __ Cobble __ Gravel __ Sand __ Silt/Clay

Still Water Present (Y/N): ____ Average Water Depth: ____ m or cm Clarity (H,M,L): ____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)	Subdominant Canopy Species (< 40 cm/16" dbh)
Liriodendron tulipifera	Carpinus caroliniana
Platanus occidentalis	Betula alleghaniensis
Acer saccharinum	Ulmus americana

Estimated dbh range: Lg: 80 Sm: 40 Estimated dbh range: Lg: 39 Sm: 10

Relative abundance of dominant vs. subdominant (ratio): 1:8

Estimated canopy closure: X Closed __ Moderate __ Open

Roost tree potential consists of: X Hollow X Large Trees X Snags __ Neither

M. sodalis roost tree potential is: __ High X Moderate __ Low

Roost potential comments: Mod roosting potential.

M. septentrionalis roost tree potential is: X High __ Moderate __ Low

Roost potential comments: High roosting potential for NLEB

Subcanopy clutter: __ Closed X Moderate __ Open

Subcanopy consists largely of: __ Lower Branches of Canopy Trees X Saplings __ Shrubs

Common Subcanopy Species: Ambrosia sp. Solidago sp. [illegible]

Check all that apply:

__ Mature Upland Forest
__ Young Upland Forest
X Mature Lowland Forest
__ Young Lowland Forest
__ Recently Logged Forest
X Forest Edge
__ Woodlot
__ Old Field
__ Crop/Pasture Land
X Stream/River
__ Vernal Pool
__ Deepwater Lake/Pond
Other: Row

Herbaceous Cover: __ Sparse __ Moderate X Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue, Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

Project #:	State/County:	Site Name/#:	Initials:

SKETCH NETS and/or DETECTORS

N

LEGEND

Net:

Detector:

DETAILED HABITAT DESCRIPTION & COMMENTS

Intersection of forest / mowed pipeline ROW and [illegible] shelter (corridor 3?).

2020

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: 10 July 2020

Project Name: Bats + Bees Site Name#: 1562-AS-022

State: IN County: Jackson

GPS Unit#: IPAD Camera/IPAD #: IPAD

Biologist (Full name) selected site Michael Monroe

Biologist (Full name) deployed detector

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
340 04101	39° 00 9.180 8"N	86° 4'9.88 06"W	10:40	07:00	IPAD	IPAD	IPAD

Provide: Information about the Detector & Microphone

___ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)	___ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ___ABII and ZCAIM
___SM 3 (___U1 or ___U2 micropone), X SM 4 (U2) ___ Mini (U2)_	Microphone Type___Standard (Black) ___ High (Green) or ___ Stainless steel_

Detector Placement/Site Description: Intersection of Unnamed Stream and ROW.

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 10 (ft) Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 1200 (ft) Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? 300 (ft) Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°) SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? 70 (ft) Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☒yes ☐no If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☒Omni Directional

How high (ft) is the microphone above ground level? 10 (ft) Compliance = 10 feet

Are calls recorded in : ☑ Full Spectrum ☒ Zero Crossing

3. Is the gear working? ☒yes ☐no Checked by (name) Michael at 12:54 (Time)

4. Is detector water-proofed? ☒Yes ☐No MCM Initial

5. What is the temperature___ (°F)? Compliance= >50 degrees F

What is the wind speed (mph)___? Compliance = <9 mph sustained

___ Precipitation for 30 minutes straight or intermittent the first 5 hours

Revised May 2020

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue, Cincinnati, OH 45232 (Phone: 513-451-1777)

HABITAT ASSESSMENT

Project #: 1562 **Date:** 7 July 2020 **State:** IN **County:** Jackson

Project Name: INFA Patch/Bees **Site Name/#:** 1562-AS-023 **USGS Quad:** NVA

Permitted Biologist: Michael Marcus (full name) **Other Field Staff:** _____ (full name) **State Permit #:** _____ **Federal Permit #:** _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude		Longitude		Picture #	Waypoint #
D	5400292	39.00795077	°N	-86.25951248	°W	DPAD	IPAD
			°N		°W		
			°N		°W		
			°N		°W		

Distance to closest water source (meters): 500 Type of water source: Pond

Water source name: Unk

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____ meters Channel Width: _____ meters Stream Width: _____ meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ____m or cm Clarity (H,M,L): ____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)
Quercus alba
Liriodendron Tulipifera
Acer saccharum

Subdominant Canopy Species (< 40 cm/16" dbh)
Cornus florida
Nyssa sylvatica
Juniperus virginiana

Estimated dbh range: Lg: 60 Sm: 40

Estimated dbh range: Lg: 39 Sm: 10

Relative abundance of dominant vs. subdominant (ratio): 10:1

Estimated canopy closure: X Closed ___Moderate ___Open

Roost tree potential consists of: ___Hollow X Large Trees X Snags ___Neither

M. sodalis roost tree potential is: ___High X Moderate ___Low

Roost potential comments: Good amount of ORT in mature forest to/edge

M. septentrionalis roost tree potential is: X High ___Moderate ___Low

Roost potential comments: Good amount of ORTs in mature woods.

Subcanopy clutter: ___Closed X Moderate ___Open

Subcanopy consists largely of: ___ Lower Branches of Canopy Trees X Saplings X Shrubs

Common Subcanopy Species: Nyssa sylvatica Cornus sp. Rhus sp.

Check all that apply:

X Mature Upland Forest
__Young Upland Forest
__Mature Lowland Forest
__Young Lowland Forest
__Recently Logged Forest
X Forest Edge
__Woodlot
__Old Field
__Crop/Pasture Land
__Stream/River
__Vernal Pool
__Deepwater Lake/Pond
Other Wildlife Openings

Herbaceous Cover: ___ Sparse ___Moderate X Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

Project #: 1562	State/County: IN / Johnson	Site Name/#: 1562-AS-002	Initials: MKM

SKETCH NETS and/or DETECTORS

N

LEGEND

Net:

Detector:

DETAILED HABITAT DESCRIPTION & COMMENTS

Upland meadow surrounded by hardwood forest.

2020

ESI

DAILY DETECTOR DEPLOYMENT DATA

Project#: IS62 Date: 10 July 2020

Project Name: INFA Bats+Bats Site Name#: IS62-AS-023

State: IN County: Jackson

GPS Unit#: IPAD Camera/IPAD #: IPAD

Biologist (Full name) selected site Michael Monroe

Biologist (Full name) deployed detector

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
54000292	39.007950 77 °N	-86.255512 48 °W	2040	0700	IPDA	IPAD	IPAD

Provide: Information about the Detector & Microphone

___ **Wildlife Acoustcs Songmeter (SM):** Please pick and model (microphone)	___ **Titley Electronics Anabat (AB):** ___ **SD 1,** ___ **SD2,** ___ **ABII and ZCAIM**
___SM 3 (___U1 or ___U2 micropone), X SM 4 (U2) ___ Mini (U2)_	**Microphone Type**___Standard (Black) ___ High (Green) or ___Stainless steel_

Detector Placement/Site Description: Forest edge meadow

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 10 (ft) Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 800 (ft) Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? 300 (ft) Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°) SM should be horizontal, AB ~45◦

How far (ft) is the detector from any potential or known roost? 50 (ft) Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☒yes ☐no If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☒Omni Directional

How high (ft) is the microphone above ground level? 10 (ft) Compliance = 10 feet

Are calls recorded in : ☒ Full Spectrum ☒ Zero Crossing

3. Is the gear working? ☒yes ☐no

Checked by (name) Monroe at 1127 (Time)

4. Is detector water-proofed? ☒Yes ☐No MCM Initial

5. What is the temperature____ (◦F)? Compliance= >50 degrees F

What is the wind speed (mph)___? Compliance = <9 mph sustained

____ Precipitation for 30 minutes straight or intermittent the first 5 hours

Revised May 2020

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

HABITAT ASSESSMENT

Project #: 1562 **Date:** July 10, 2020 **State:** IN **County:** Jackson

Project Name: IFA Bats **Site Name/#:** 1562-AS-027 **USGS Quad:** Unk

Permitted Biologist: P. Reeher Jake V. (full name) Other Field Staff: _____ (full name) State Permit #: _____ Federal Permit #: _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
1562-AS-027	SMU0[illegible]	39.00276324 °N	-86.16975933 °W		
		°N	°W		
		°N	°W		
		°N	°W		

Distance to closest water source (meters): 1760 Type of water source: Pond

Water source name: N/A

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____meters Channel Width: _____meters Stream Width: _____meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ____m or cm Clarity (H,M,L):____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)
Quercus alba

Subdominant Canopy Species (< 40 cm/16" dbh)
Quercus montana
Acer saccharum
Fagus grandifolia

Estimated dbh range: Lg: 25 Sm: 20 Estimated dbh range: Lg: 15 Sm: 10

Relative abundance of dominant vs. subdominant (ratio): 1:5

Estimated canopy closure: ___Closed ✓Moderate ___Open

Roost tree potential consists of: ___Hollow ✓Large Trees ✓Snags ___ Neither

M. sodalis roost tree potential is: ___High ✓Moderate ___Low

Roost potential comments: open logging road containing a few snags

M. septentrionalis roost tree potential is: ___High ✓Moderate ___Low

Roost potential comments: open logging road containing a few snags

Subcanopy clutter: ___Closed ✓Moderate ___Open

Subcanopy consists largely of: ✓Lower Branches of Canopy Trees ✓Saplings ✓Shrubs

Common Subcanopy Species: Quercus montana Acer Saccharum Fagus grandifolia

Check all that apply:

__Mature Upland Forest	__Recently Logged Forest	__Crop/Pasture Land	Other _____
✓Young Upland Forest	__Forest Edge	__Stream/River	_____
__Mature Lowland Forest	__Woodlot	__Vernal Pool	_____
__Young Lowland Forest	__Old Field	__Deepwater Lake/Pond	_____

Herbaceous Cover: ___ Sparse ✓Moderate ___Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

Project #:	State/County:	Site Name/#:	Initials:

SKETCH NETS and/or DETECTORS

N

LEGEND	DETAILED HABITAT DESCRIPTION & COMMENTS
Net:	
Detector:	

ESI

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: July 10, 2020

Project Name: IFA Bats Site Name#: 1562-AS-027

State: Indiana County: Jackson

GPS Unit#: IPAD Camera/IPAD #: 425

Biologist (Full name) selected site _____

Biologist (Full name) deployed detector P Reeher Jared K.

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
SMU00947	39.00276324 "N	-86.18975933 W	20:42	6:59	IPAD		

Provide: Information about the Detector & Microphone

___ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)	___ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ___ABII and ZCAIM
___SM 3 (___U1 or ___U2 micropone), ___SM 4 (U2) ___Mini (U2)	Microphone Type___Standard (Black) ___ High (Green) or ___Stainless steel_

Detector Placement/Site Description: _____

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 15 (ft) Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 2350 (ft) Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? 200+ (ft) Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°) SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? 50 (ft) Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☑yes ☐no If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☐Omni Directional

How high (ft) is the microphone above ground level? 10 (ft) Compliance = 10 feet

Are calls recorded in : ☑Full Spectrum ☑Zero Crossing

3. Is the gear working? ☑yes ☐no

Checked by (name) Jared K at 1630 (Time)

4. Is detector water-proofed? ☑Yes ☐No

JK Initial

5. What is the temperature 82 (°F)? Compliance= >50 degrees F

What is the wind speed (mph) 0-3? Compliance = <9 mph sustained

_____ Precipitation for 30 minutes straight or intermittent the first 5 hours

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue, Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT

Project #: 1562 **Date:** July 10, 2020 **State:** IN **County:** Jackson

Project Name: I FA Bats **Site Name/#:** 1562-AS-028 **USGS Quad:** Unk

Permitted Biologist: _____ (full name) Other Field Staff: _____ (full name) State Permit #: _____ Federal Permit #: _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
Detector	SMU00858	39.033596 °N	-86.197933 °W		
		°N	°W		
		°N	°W		
		°N	°W		

Distance to closest water source (meters): 515 Type of water source: Pond

Water source name: N/A

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____meters Channel Width: _____meters Stream Width: _____meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ____m or cm Clarity (H,M,L):____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)

_____

_____

_____

Subdominant Canopy Species (< 40 cm/16" dbh)

Lereodendron tulipifera

Juglans nigra

Platanus occidentalis

Estimated dbh range: Lg: _____ Sm: _____ Estimated dbh range: Lg: _____ Sm: _____

Relative abundance of dominant vs. subdominant (ratio): 0:1

Estimated canopy closure: ___Closed ✓Moderate ___Open

Roost tree potential consists of: ___Hollow ✓Large Trees ___Snags ___ Neither

M. sodalis roost tree potential is: ___High ___Moderate ✓Low

Roost potential comments: Few large trees with exfoliating bark.

M. septentrionalis roost tree potential is: ___High ✓Moderate ___Low

Roost potential comments: Few large trees with exfoliating bark.

Subcanopy clutter: ___Closed ✓Moderate ___Open

Subcanopy consists largely of: ✓ Lower Branches of Canopy Trees ✓Saplings ___Shrubs

Common Subcanopy Species: Juglans nigra Lereodendron tulipifera Platanus occidentalis

Check all that apply:

__Mature Upland Forest
✓Young Upland Forest
__Mature Lowland Forest
__Young Lowland Forest
__Recently Logged Forest
✓Forest Edge
__Woodlot
__Old Field
__Crop/Pasture Land
__Stream/River
__Vernal Pool
__Deepwater Lake/Pond
Other planted pines

Herbaceous Cover: ___ Sparse ___Moderate ✓Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

Project #:	State/County:	Site Name/#:	Initials:

SKETCH NETS and/or DETECTORS

N

LEGEND	DETAILED HABITAT DESCRIPTION & COMMENTS
Net: ●——●	cleared crop and surrounded by young upland forest with few large trees and snags within.
Detector:	

2020

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

DAILY DETECTOR DEPLOYMENT DATA

Project#: 562 Date: July 10, 2020
Project Name: IEA Bats Site Name#: 1562-AS-030
State: Indiana County: Jackson
GPS Unit#: IPAD Camera/IPAD #: 425
Biologist (Full name) selected site
Biologist (Full name) deployed detector P. Rieber Jared K.

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
	39.00335966 "N	-86.19793307 "W	20:42	6:59	IPAD		

Provide: Information about the Detector & Microphone

___ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)
___SM 3 (___U1 or ___U2 micropone), ___SM 4 (U2) ___Mini (U2)

___ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ___ABII and ZCAIM
Microphone Type ___Standard (Black) ___ High (Green) or ___Stainless steel

Detector Placement/Site Description:

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 20 (ft)
Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 656 (ft)
Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? 500 (ft)
Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°)
SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? 50 (ft)
Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☑yes ☐no
If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☑Omni Directional

How high (ft) is the microphone above ground level? 10 (ft)
Compliance = 10 feet

Are calls recorded in :
☑ Full Spectrum
☑ Zero Crossing

3. Is the gear working? ☑yes ☐no
Checked by (name) Jared K at 12:56 (Time)

4. Is detector water-proofed? ☑Yes ☐No ___Initial

5. What is the temperature 76.4 (°F)?
Compliance= >50 degrees F

What is the wind speed (mph) 1-2?
Compliance = <9 mph sustained

___ Precipitation for 30 minutes straight or intermittent the first 5 hours

Revised May 2020

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

HABITAT ASSESSMENT

Project #: 1562 Date: July 10, 2020 State: IN County: Jackson

Project Name: IFA Bats Site Name/#: 1562-NS-029 USGS Quad: Unk

Permitted Biologist: P. Recher Jared K Other Field Staff: _____ State Permit #: _____

(full name) (full name) Federal Permit #: _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
1562-NS-029	EM U00801	39.00097315 °N	-86.29637464 °W		
		°N	°W		
		°N	°W		
		°N	°W		

Distance to closest water source (meters): 1090 Type of water source: Pond

Water source name: N/A

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____meters Channel Width: _____meters Stream Width: _____meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ___m or cm Clarity (H,M,L): ____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)

Quercus montana

Subdominant Canopy Species (< 40 cm/16" dbh)

Quercus rubra

Liriodendron tulipifera

Acer rubrum

Estimated dbh range: Lg: 25 Sm: 20 Estimated dbh range: Lg: 15 Sm: 10

Relative abundance of dominant vs. subdominant (ratio): 1:5

Estimated canopy closure: ___Closed √Moderate ___Open

Roost tree potential consists of: ___Hollow √Large Trees √Snags ___ Neither

M. sodalis roost tree potential is: ___High √Moderate ___Low

Roost potential comments: Few snags with proper light exposure

M. septentrionalis roost tree potential is: ___High √Moderate ___Low

Roost potential comments: Few snags with proper light exposure

Subcanopy clutter: ___Closed √Moderate ___Open

Subcanopy consists largely of: √Lower Branches of Canopy Trees √Saplings ___Shrubs

Common Subcanopy Species: Quercus rubra Liriodendron tulipifera Acer rubrum

Check all that apply:

__Mature Upland Forest
√Young Upland Forest
__Mature Lowland Forest
__Young Lowland Forest
__Recently Logged Forest
√Forest Edge
__Woodlot
__Old Field
__Crop/Pasture Land
__Stream/River
__Vernal Pool
__Deepwater Lake/Pond
Other Riprap R.O.W

Herbaceous Cover: ___ Sparse ___Moderate √Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

Project #:	State/County:	Site Name/#:	Initials:

SKETCH NETS and/or DETECTORS

N

LEGEND	DETAILED HABITAT DESCRIPTION & COMMENTS
Net:	
Detector:	

2020

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: July 10, 2020
Project Name: IFA Bats Site Name#: 1562-AS-029
State: IN County: Jackson
GPS Unit#: IPAD Camera/IPAD #: 425
Biologist (Full name) selected site
Biologist (Full name) deployed detector P. Recher; Jared Kleinhenz

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
SMU00461	39.0897315 "N	-86.20637464 "W	20:42	6:59	IPAD		

Provide: Information about the Detector & Microphone

___ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)
___SM 3 (___U1 or ___U2 micropone), ___SM 4 (U2) ___Mini (U2)

___ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ___ABII and ZCAIM
Microphone Type___Standard (Black) ___ High (Green) or ___Stainless steel_

Detector Placement/Site Description:

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 20 (ft)
Compliance = 10 feet minimum

How far (ft) is the detector from another detector? ___(ft)
Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? 400 (ft)
Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°)
SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? 50 (ft)
Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☑yes ☐no
If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☑Omni Directional

How high (ft) is the microphone above ground level? 10 (ft)
Compliance = 10 feet

Are calls recorded in :
☑ Full Spectrum
☑ Zero Crossing

3. Is the gear working? ☑yes ☐no

Checked by (name) Jared K at 14:10 (Time)

4. Is detector water-proofed? ☐Yes ☐No JK Initial

5. What is the temperature 83.9 (°F)?
Compliance= >50 degrees F

What is the wind speed (mph) 3 ?
Compliance = <9 mph sustained

___ Precipitation for 30 minutes straight or intermittent the first 5 hours

Revised May 2020

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

HABITAT ASSESSMENT

Project #: 1562 **Date:** July 10, 2020 **State:** IN **County:** Jackson

Project Name: IFA Bats **Site Name/#:** 1562-AS-030 **USGS Quad:** unk

Permitted Biologist: P. Reeher Jared K (full name) Other Field Staff: _____ (full name) State Permit #: _____ Federal Permit #: _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
1562-AS-030	SMU000853	39.035107532 °N	-86.205776631 °W		
		°N	°W		
		°N	°W		
		°N	°W		

Distance to closest water source (meters): 2,074 Type of water source: Pond

Water source name: N/A

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____meters Channel Width: _____meters Stream Width: _____meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ____m or cm Clarity (H,M,L):____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)	Subdominant Canopy Species (< 40 cm/16" dbh)
Quercus alba	Magnolia acuminata
	Acer rubrum
	Cornus florida

Estimated dbh range: Lg: 25 Sm: 20 Estimated dbh range: Lg: 15 Sm: 15

Relative abundance of dominant vs. subdominant (ratio): 1:5

Estimated canopy closure: ___Closed ✓Moderate ___Open

Roost tree potential consists of: ___Hollow ✓Large Trees ✓Snags ___ Neither

M. sodalis roost tree potential is: ___High ✓Moderate ___Low

Roost potential comments: Few large trees/snags with exfoliating bark and proper sun exposure

M. septentrionalis roost tree potential is: ___High ✓Moderate ___Low

Roost potential comments: Few large trees/snags with exfoliating bark

Subcanopy clutter: ___Closed ✓Moderate ___Open

Subcanopy consists largely of: ✓Lower Branches of Canopy Trees ✓Saplings ___Shrubs

Common Subcanopy Species: Acer rubrum Cornus florida Magnolia acuminata

Check all that apply:

__Mature Upland Forest	__Recently Logged Forest	__Crop/Pasture Land	Other Pipeline Road
✓Young Upland Forest	✓Forest Edge	__Stream/River	
__Mature Lowland Forest	__Woodlot	__Vernal Pool	
__Young Lowland Forest	__Old Field	__Deepwater Lake/Pond	

Herbaceous Cover: ___ Sparse ✓Moderate ___Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue, Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

Project #:	State/County:	Site Name/#:	Initials:

SKETCH NETS and/or DETECTORS

N

LEGEND	DETAILED HABITAT DESCRIPTION & COMMENTS
Net: ●——●	Detector placed along pipline R.O.W. Pipline R.O.W. crosses through young upland forest with few snags throughout.
Detector: ▭	

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: July 10, 2020

Project Name: IFA Bats Site Name#: 1562-AS-030

State: In County: Jackson

GPS Unit#: IPAD Camera/IPAD #: IPAD

Biologist (Full name) selected site _____

Biologist (Full name) deployed detector Jared K, P Reecher

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-45	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
	39.°05167528 "N	-86.°20576631 "W	20:42	6:59	IPAD		

Provide: Information about the Detector & Microphone

___ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)
___SM 3 (___U1 or ___U2 micropone), ___SM 4 (U2) ___Mini (U2)

___ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ___ABII and ZCAIM
Microphone Type____Standard (Black) ___ High (Green) or ___Stainless steel_

Detector Placement/Site Description: _____

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 20 (ft)
Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 656 (ft)
Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? 200 (ft)
Compliance = 33 feet minimum

What is the angle of the microphone? _____(°)
SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? _____(ft)
Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☑yes ☐no
If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☑Omni Directional

How high (ft) is the microphone above ground level? _____(ft)
Compliance = 10 feet

Are calls recorded in :
☑Full Spectrum
☑Zero Crossing

3. Is the gear working? ☑yes ☐no

Checked by (name) Jared K at _____(Time)

4. Is detector water-proofed? ☑Yes ☐No _____Initial

5. What is the temperature 58 (°F)?
Compliance= >50 degrees F

What is the wind speed (mph) 12 ?
Compliance = <9 mph sustained

____ Precipitation for 30 minutes straight or intermittent the first 5 hours

Revised May 2020

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue, Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT

Project #: 1562 **Date:** 10 July 2020 **State:** IN **County:** Jackson

Project Name: INFA Bats + Bridges **Site Name/#:** 1562-AS-031 **USGS Quad:** Unk

Permitted Biologist: Michael Monroe (full name) Other Field Staff: _____ (full name) State Permit #: _____ Federal Permit #: _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
D	54U00559	39.62260494 °N	-86.28219210 °W	1010	1041
		°N	°W		
		°N	°W		
		°N	°W		

Distance to closest water source (meters): 3 Type of water source: Stream

Water source name: Fleetwood Branch

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: 2 meters Channel Width: 6 meters Stream Width: 1 meters

Substratum: ___Bedrock ___Boulder ___Cobble X Gravel X Sand ___Silt/Clay

Still Water Present (Y/N): N Average Water Depth: 0 m or cm Clarity (H,M,L): N/A

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)	Subdominant Canopy Species (< 40 cm/16" dbh)
Acer saccharum	Carpinus caroliniana
Liriodendron tulipifera	tree regrowth
Juglans nigra	Cercis canadensis

Estimated dbh range: Lg: 60 Sm: 40 Estimated dbh range: Lg: 40 Sm: 10

Relative abundance of dominant vs. subdominant (ratio): 10:1

Estimated canopy closure: X Closed ___Moderate ___Open

Roost tree potential consists of: X Hollow X Large Trees X Snags ___ Neither

M. sodalis roost tree potential is: X High ___Moderate ___Low

Roost potential comments: Open forest w/ abundance of roosts w/ access to water

M. septentrionalis roost tree potential is: X High ___Moderate ___Low

Roost potential comments: Open forest w/ abundance of roosts w/ water access

Subcanopy clutter: ___Closed X Moderate ___Open

Subcanopy consists largely of: ___ Lower Branches of Canopy Trees X Saplings X Shrubs

Common Subcanopy Species: Aesculus flava, asimina triloba, Rubus sp.

Check all that apply:

__Mature Upland Forest	__Recently Logged Forest	__Crop/Pasture Land	Other _____
__Young Upland Forest	X Forest Edge	X Stream/River	
X Mature Lowland Forest	__Woodlot	__Vernal Pool	
__Young Lowland Forest	__Old Field	__Deepwater Lake/Pond	

Herbaceous Cover: ___ Sparse ___Moderate X Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue, Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

Project #: 562	State/County: IN/Jackson	Site Name/#: AS-031	Initials: MCM

SKETCH NETS and/or DETECTORS

N

LEGEND

Net:

Detector:

DETAILED HABITAT DESCRIPTION & COMMENTS

Area at intersection of road and stream bed. Forest is green.

2020

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: 10 July 2020

Project Name: INFA Beech Bats Site Name#: 1562-AS-03)

State: IN County: Jackson

GPS Unit#: IPAD Camera/IPAD #: IPAD

Biologist (Full name) selected site Michael Malrose

Biologist (Full name) deployed detector

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
SYU00559	39.03263194 °N	-86.28219210 °W	2040	07:00	IPAD	IPAD	IPAD

Provide: Information about the Detector & Microphone

___ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)
___ SM 3 (___ U1 or ___ U2 micropone), X SM 4 (U2) ___ Mini (U2)_

___ Titley Electronics Anabat (AB): ___ SD 1, ___ SD2, ___ ABII and ZCAIM
Microphone Type ___ Standard (Black) ___ High (Green) or ___ Stainless steel_

Detector Placement/Site Description: Along dry stream bed, area opens up to road.

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 10 (ft)
Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 2660 (ft)
Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? 200 (ft)
Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°)
SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? 60 (ft)
Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☒yes ☐no
If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☒Omni Directional

How high (ft) is the microphone above ground level? 10 (ft)
Compliance = 10 feet

Are calls recorded in :
☒ Full Spectrum
☒ Zero Crossing

3. Is the gear working? ☒yes ☐no

Checked by (name) Malrose at 11:42 (Time)

4. Is detector water-proofed? ☒Yes ☐No ___ Initial

5. What is the temperature___ (°F)?
Compliance= >50 degrees F

What is the wind speed (mph)___?
Compliance = <9 mph sustained

___ Precipitation for 30 minutes straight or intermittent the first 5 hours

Revised May 2020

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue, Cincinnati, OH 45232 (Phone: 513-451-1777)

HABITAT ASSESSMENT

Project #: 1562 Date: 10 July 2020 State: IN County: Jackson

Project Name: INFA Bats + Cores Site Name/#: 1562-AS-032 USGS Quad: Ora

Permitted Biologist: Michael Mayfield (full name) Other Field Staff: _____ (full name) State Permit #: _____ Federal Permit #: _____

Net/Trap/ Detector	Net/Trap/ Detector #	Latitude	Longitude	Picture #	Waypoint #
D	SM100ST	39.021398 °N	-86.287669 °W	IMG	1PAD
		°N	°W		
		°N	°W		
		°N	°W		

Distance to closest water source (meters): 50 Type of water source: Stream

Water source name: Fleetwood Branch

ESTIMATED WATER SOURCE CHARACTERISTICS (IF UNDER NETS OR DETECTOR):

Bank Height: _____meters Channel Width: _____meters Stream Width: _____meters

Substratum: ___Bedrock ___Boulder ___Cobble ___Gravel ___Sand ___Silt/Clay

Still Water Present (Y/N): _____ Average Water Depth: ____m or cm Clarity (H,M,L): ____

VEGETATION:

Dominant Canopy Species (> 40 cm/16" dbh)
Liriodendron tulipifera
Juglans nigra
Prunus serotina

Subdominant Canopy Species (< 40 cm/16" dbh)
Liriodendron tulipifera
Acer rubrum
Cornus caroliniana

Estimated dbh range: Lg: 60 Sm: 10 Estimated dbh range: Lg: 39 Sm: 10

Relative abundance of dominant vs. subdominant (ratio): 1:10

Estimated canopy closure: ___Closed ___Moderate X Open

Roost tree potential consists of: ___Hollow X Large Trees X Snags ___ Neither

M. sodalis roost tree potential is: ___High X Moderate ___Low

Roost potential comments: Moderate, Lacks HOBTS

M. septentrionalis roost tree potential is: X High ___Moderate ___Low

Roost potential comments: _____

Subcanopy clutter: ___Closed ___Moderate X Open

Subcanopy consists largely of: ___ Lower Branches of Canopy Trees X Saplings ___Shrubs

Common Subcanopy Species: Area was just cleared / maintained

Check all that apply:

__Mature Upland Forest	__Recently Logged Forest	__Crop/Pasture Land	Other _____
__Young Upland Forest	X Forest Edge	__Stream/River	_____
X Mature Lowland Forest	__Woodlot	__Vernal Pool	_____
__Young Lowland Forest	X Old Field	__Deepwater Lake/Pond	_____

Herbaceous Cover: X Sparse ___Moderate ___Dense

2019

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

HABITAT ASSESSMENT (continued)

Project #: 1562	State/County: IN/Jackson	Site Name/#: HS-032	Initials: MLM

SKETCH NETS and/or DETECTORS

N

LEGEND

Net:

Detector:

DETAILED HABITAT DESCRIPTION & COMMENTS

Maintained wildlife opening surrounded by forest.

Property of: Environmental Solutions & Innovations, Inc.
4525 Este Avenue. Cincinnati, OH 45232 (Phone: 513-451-1777)

ESI

DAILY DETECTOR DEPLOYMENT DATA

Project#: 1562 Date: 7 July 2020

Project Name: INFA Bat st Bees Site Name#: 1562-AS-032

State: IN County: Jackson

GPS Unit#: IOAD Camera/IPAD #: IOAD

Biologist (Full name) selected site Michael Maiose

Biologist (Full name) deployed detector

Wind Speed (mph)	Description	Visible Condition	Wind Speed (mph)	Description	Visible Condition
0	Calm	Smoke rises vertically	19-24	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets on inland water
1-3	Light Air	Direction of wind shown by smoke but not by wind vanes	25-31	Strong Breeze	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
4-7	Light Breeze	Wind felt on face; leaves rustle; ordinary wind vane moved by wind	32-38	Moderate Gale	Whole trees in motion; inconvenience in walking against wind
8-12	Gentle Breeze	Leaves and small twigs in constant motion; wind extends light flag	39-46	Fresh Gale	Breaks twigs off trees; generally impedes progress
13-18	Moderate Breeze	Raises dust and loose paper; small branches are moved			

FILL IN THE FOLLOWING FOR EACH DETECTOR SET

Detector # Red Tag	Latitude	Longitude	Time Up (xxxx h)	Time Down (xxxx h)	Photo #Detector	Photo # Cone	Waypoint #
SMU00552	39.021396 92°N	-86.28966994 °W	20:40	07:00	IOAD	IPAD	IPAD

Provide: Information about the Detector & Microphone

___ Wildlife Acoustcs Songmeter (SM): Please pick and model (microphone)	___ Titley Electronics Anabat (AB): ___SD 1, ___SD2, ___ABII and ZCAIM
____SM 3 (___U1 or ___U2 micropone), ____SM 4 (U2) __X Mini (U2)_	Microphone Type____Standard (Black) ___ High (Green) or ___Stainless steel_

Detector Placement/Site Description: In open area surrounded by forest

DETECTOR CHECKLIST (Initial each blank as you verify each issue)

1. How far (ft) is the detector from vegetative clutter on the ground in all directions? 10 (ft) Compliance = 10 feet minimum

How far (ft) is the detector from another detector? 2000 (ft) Compliance = 656 feet minimum

How far (ft) is the microphone from vegetation in front of it? 100 (ft) Compliance = 33 feet minimum

What is the angle of the microphone? 0 (°) SM should be horizontal, AB ~45°

How far (ft) is the detector from any potential or known roost? 80 (ft) Compliance = 50 feet minimum

Is the detector Parallel to woodland? ☒yes ☐no If not, WHY?

2. Is the Microphone? ☐Directional ☐ Hemispherical ☒Omni Directional

How high (ft) is the microphone above ground level? 10 (ft) Compliance = 10 feet

Are calls recorded in : ☒ Full Spectrum ☒ Zero Crossing

3. Is the gear working? ☒yes ☐no

Checked by (name) Maiose at 1512 (Time)

4. Is detector water-proofed? ☒Yes ☐No MCM Initial

5. What is the temperature____ (°F)? Compliance= >50 degrees F

What is the wind speed (mph)____? Compliance = <9 mph sustained

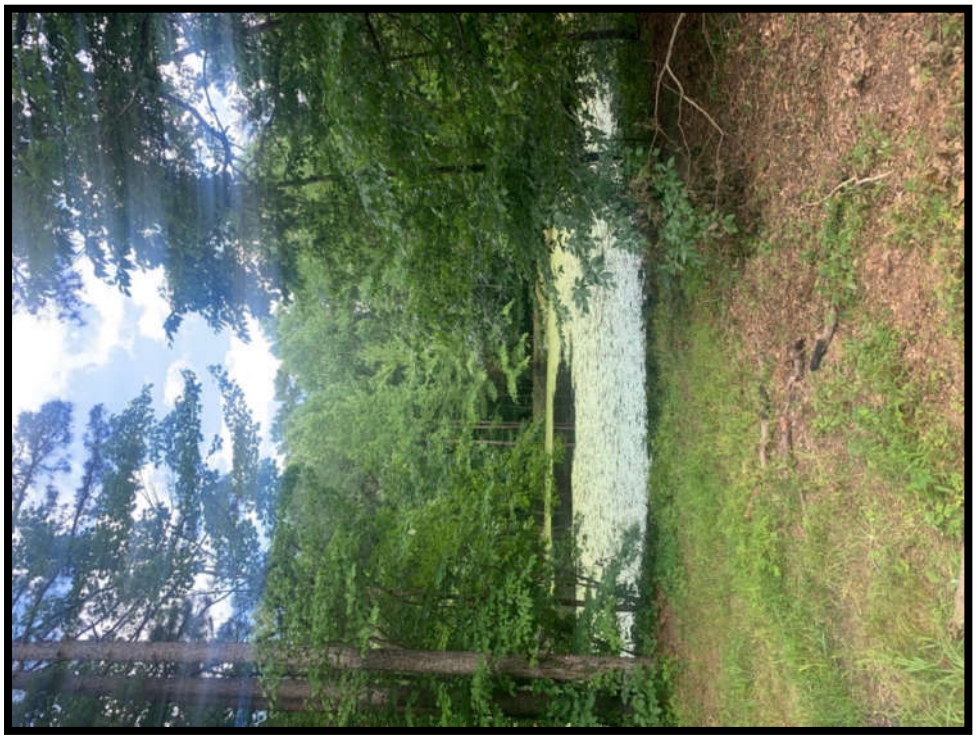
____ Precipitation for 30 minutes straight or intermittent the first 5 hours

Revised May 2020

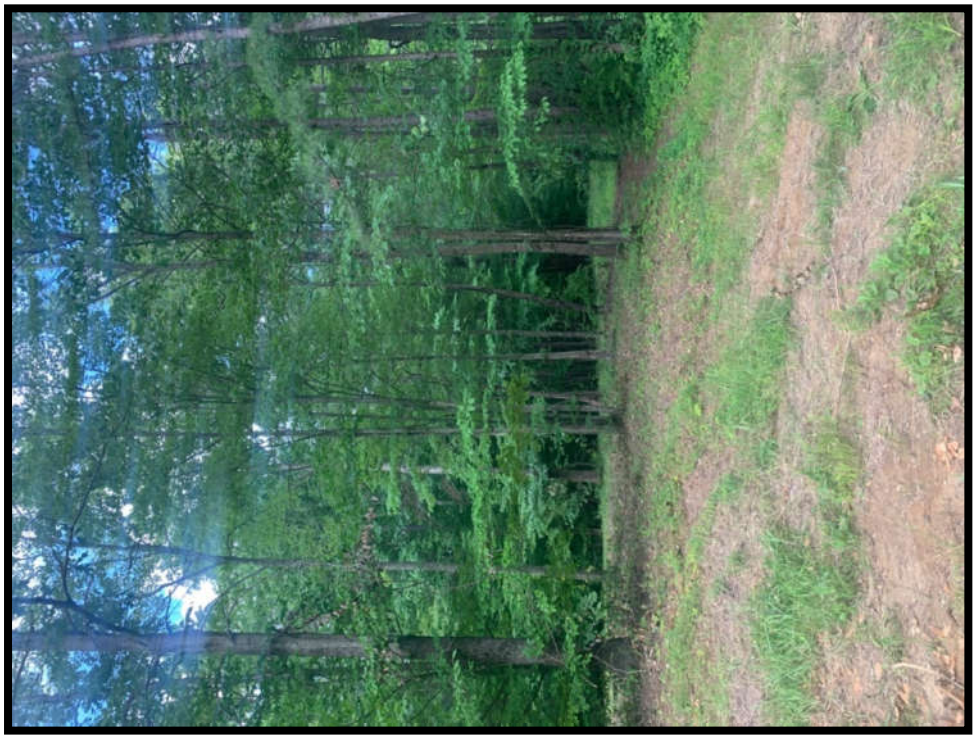
APPENDIX C
REPRESENTATIVE PHOTOGRAPHS

1562-AS-001 Area of Detection (1 of 4)

1562-AS-001 Acoustic Detector



1562-AS-001 Area of Detection (3 of 4)



1562-AS-001 Area of Detection (2 of 4)

1562-AS-001 Area of Detection (4 of 4)

1562-AS-002 Area of Detection (1 of 4)

1562-AS-002 Area of Detection (2 of 4)

1562-AS-002 Area of Detection (3 of 4)

1562-AS-002 Area of Detection (4 of 4)

1562-AS-003 Area of Detection (1 of 4)

1562-AS-002 Area of Detection (2 of 4)

1562-AS-003 Area of Detection (3 of 4)

1562-AS-003 Area of Detection (4 of 4)

1562-AS-005 Area of Detection (1 of 4)

1562-AS-005 Area of Detection (2 of 4)

1562-AS-005 Area of Detection (3 of 4)

1562-AS-005 Area of Detection (4 of 4)

1562-AS-008 Acoustic Detector

1562-AS-008 Area of Detection (1 of 4)

1562-AS-008 Area of Detection (2 of 4)

1562-AS-008 Area of Detection (3 of 4)

1562-AS-008 Area of Detection (4 of 4)

1562-AS-009 Area of Detection (1 of 4)

1562-AS-009 Area of Detection (2 of 4)

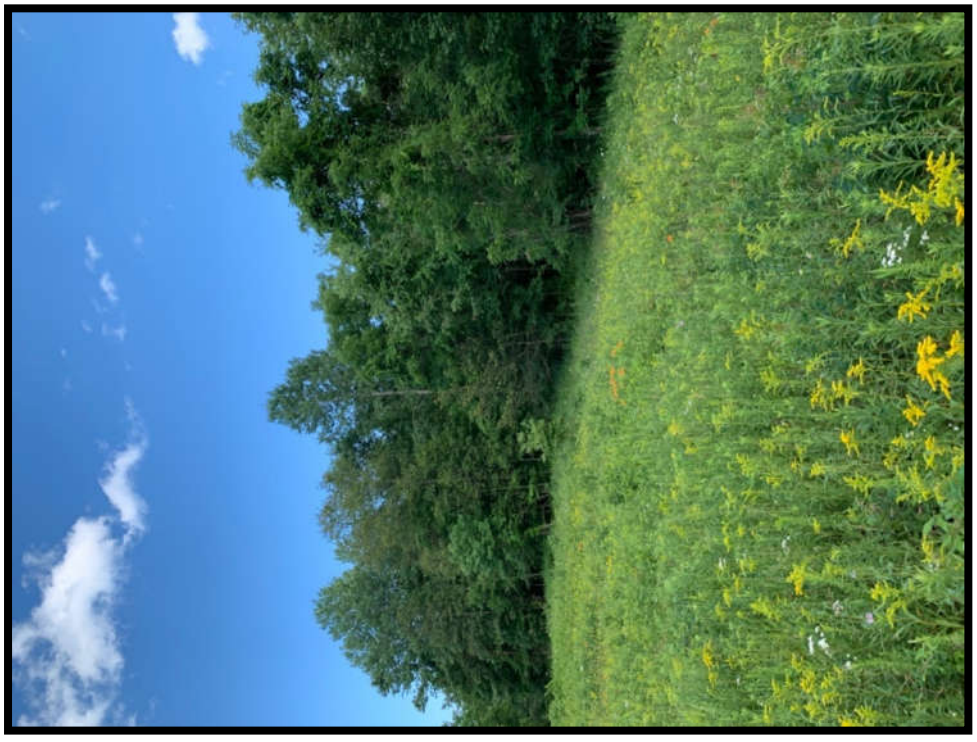
1562-AS-009 Area of Detection (3 of 4)

1562-AS-009 Area of Detection (4 of 4)

1562-AS-010 Area of Detection (1 of 4)

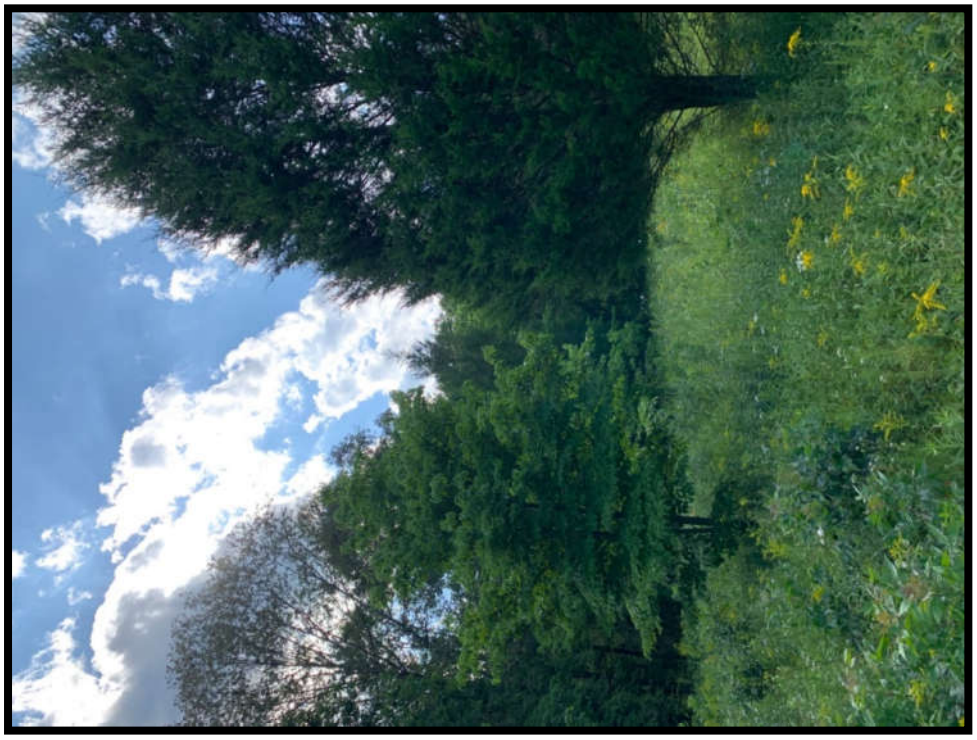
1562-AS-010 Acoustic Detector

1562-AS-010 Area of Detection (3 of 4)



1562-AS-010 Area of Detection (2 of 4)

1562-AS-011 Acoustic Detector

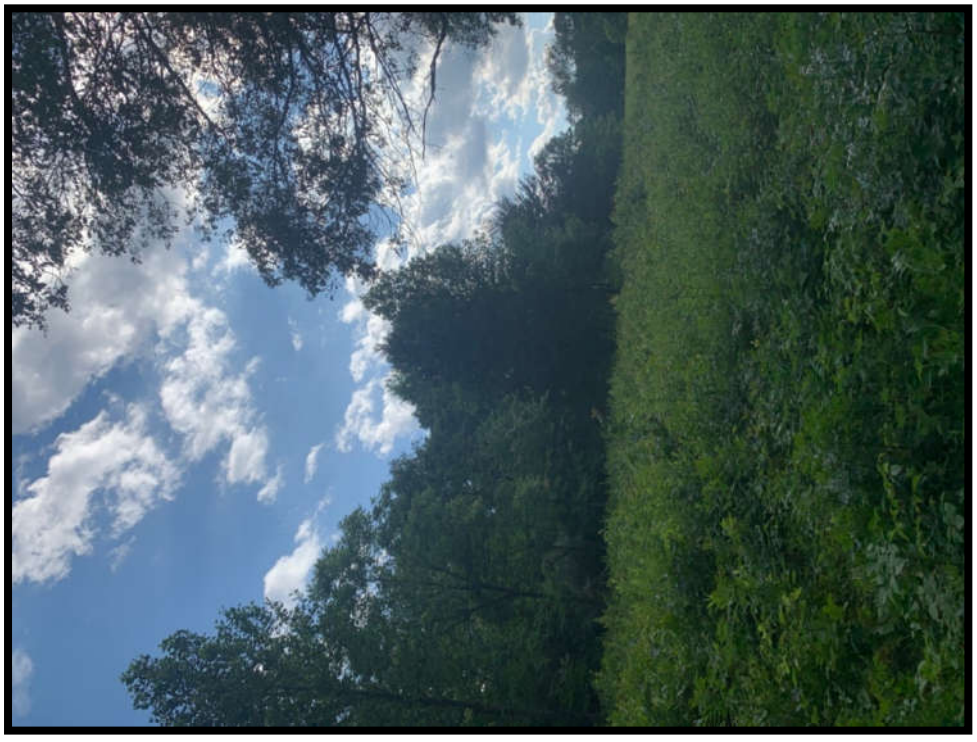


1562-AS-010 Area of Detection (4 of 4)

1562-AS-011 Area of Detection (2 of 4)

1562-AS-011 Area of Detection (1 of 4)

1562-AS-011 Area of Detection (4 of 4)



1562-AS-011 Area of Detection (3 of 4)

1562-AS-012 Area of Detection (1 of 4)

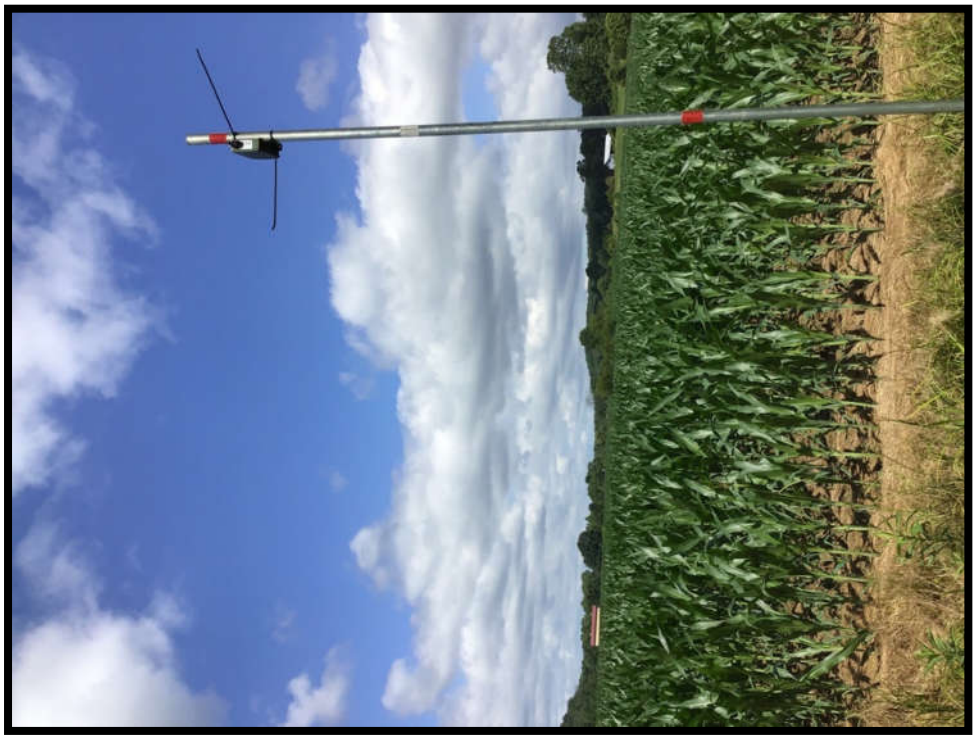
1562-AS-012 Area of Detection (2 of 4)

1562-AS-012 Area of Detection (3 of 4)

1562-AS-012 Area of Detection (4 of 4)

1562-AS-014 Acoustic Detector

1562-AS-013 Acoustic Detector



1562-AS-016 Acoustic Detector

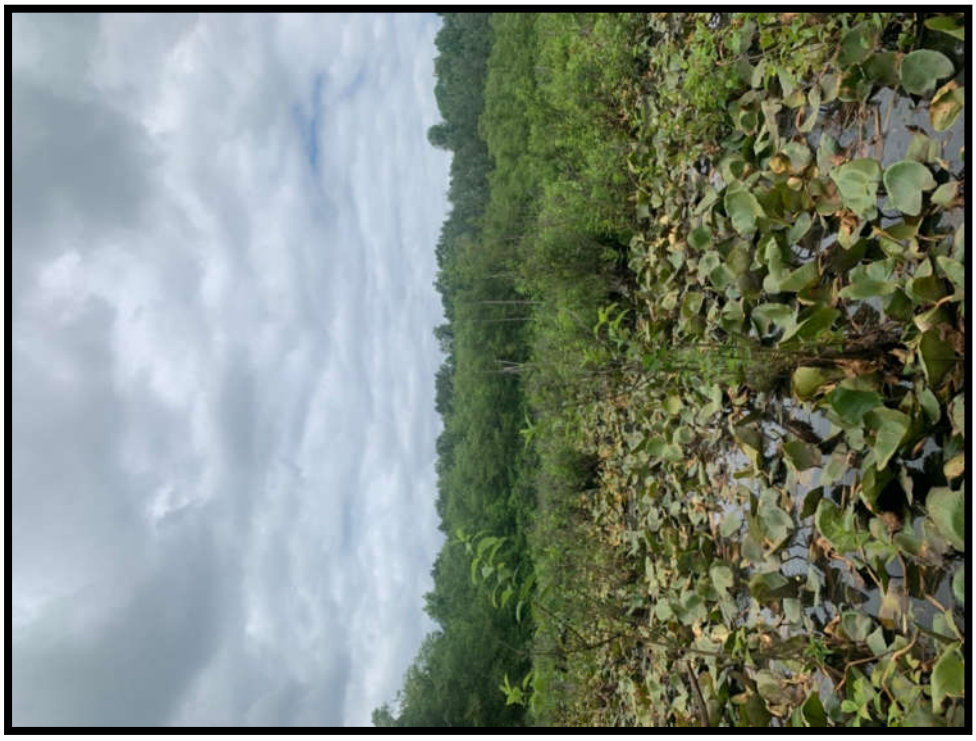
1562-AS-015 Acoustic Detector

1562-AS-018 Area of Detection (1 of 4)

1562-AS-018 Area of Detection (2 of 4)

1562-AS-018 Area of Detection (3 of 4)

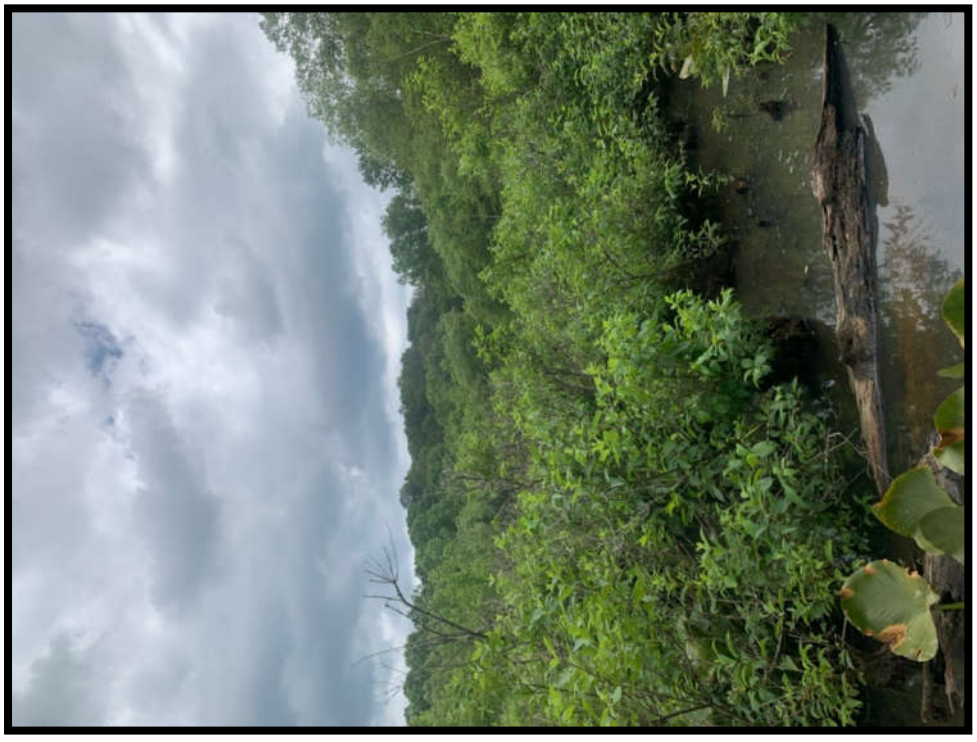
1562-AS-018 Area of Detection (4 of 4)



1562-AS-020 Area of Detection (1 of 4)

1562-AS-020 Acoustic Detector

1562-AS-020 Area of Detection (3 of 4)



1562-AS-020 Area of Detection (2 of 4)

1562-AS-021 Acoustic Detector

1562-AS-020 Area of Detection (4 of 4)

1562-AS-021 Area of Detection (2 of 4)

1562-AS-021 Area of Detection (1 of 4)

1562-AS-021 Area of Detection (4 of 4)

1562-AS-021 Area of Detection (3 of 4)

1562-AS-022 Area of Detection (1 of 4)

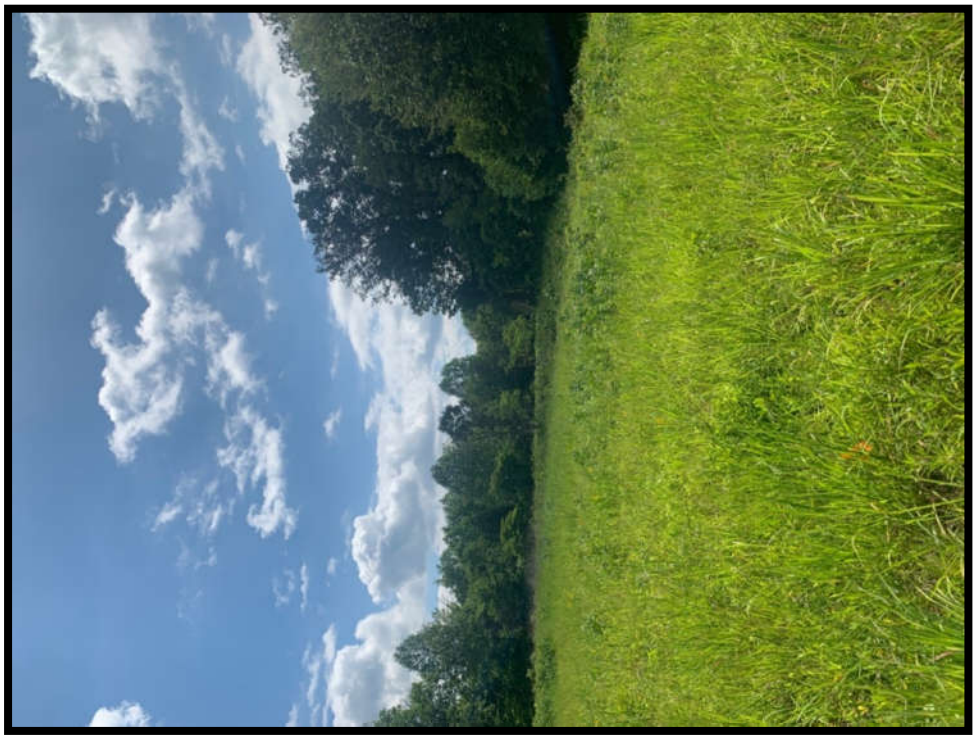
1562-AS-022 Acoustic Detector

1562-AS-022 Area of Detection (3 of 4)

1562-AS-022 Area of Detection (2 of 4)

1562-AS-023 Acoustic Detector

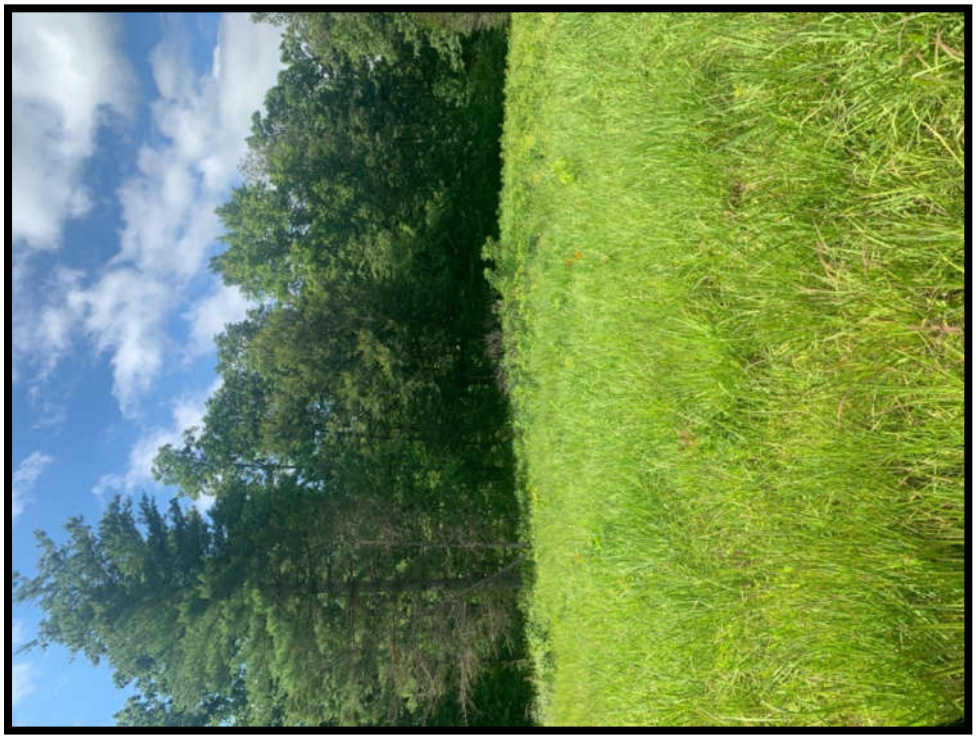
1562-AS-022 Area of Detection (4 of 4)



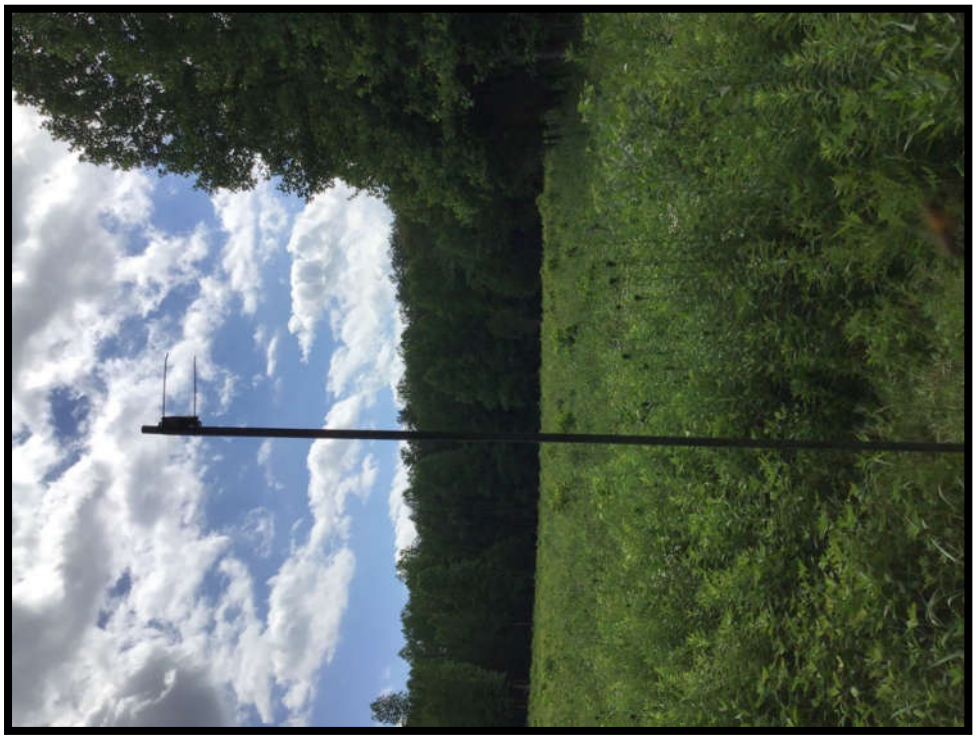
1562-AS-023 Area of Detection (2 of 4)

1562-AS-023 Area of Detection (1 of 4)

1562-AS-023 Area of Detection (4 of 4)



1562-AS-023 Area of Detection (3 of 4)



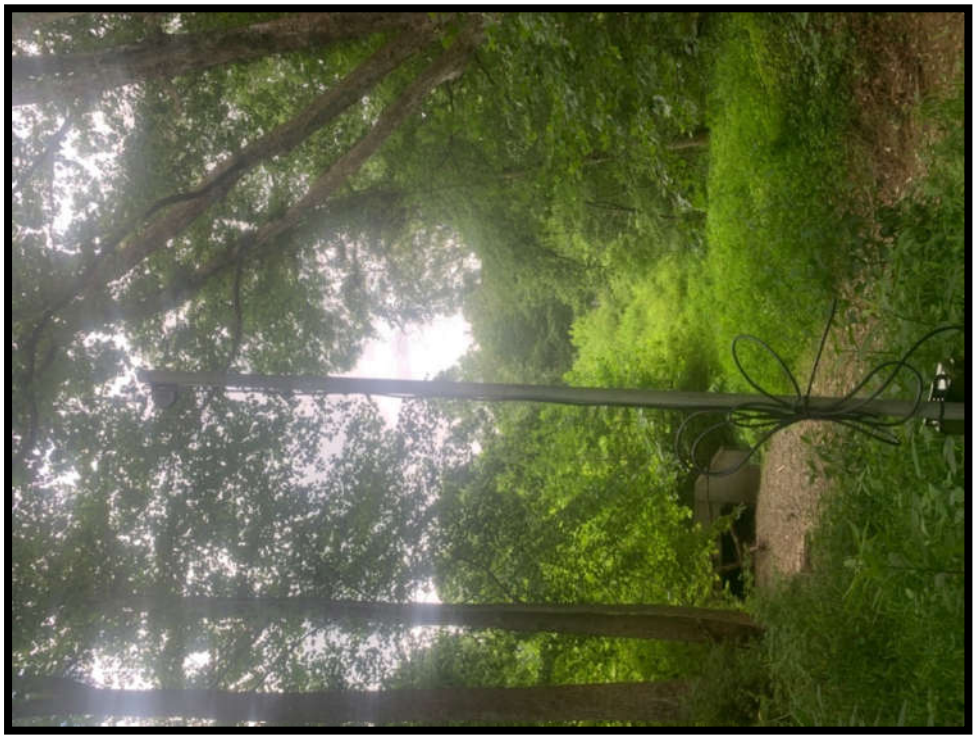
1562-AS-028 Acoustic Detector

1562-AS-027 Acoustic Detector

1562-AS-030 Acoustic Detector

1562-AS-029 Acoustic Detector

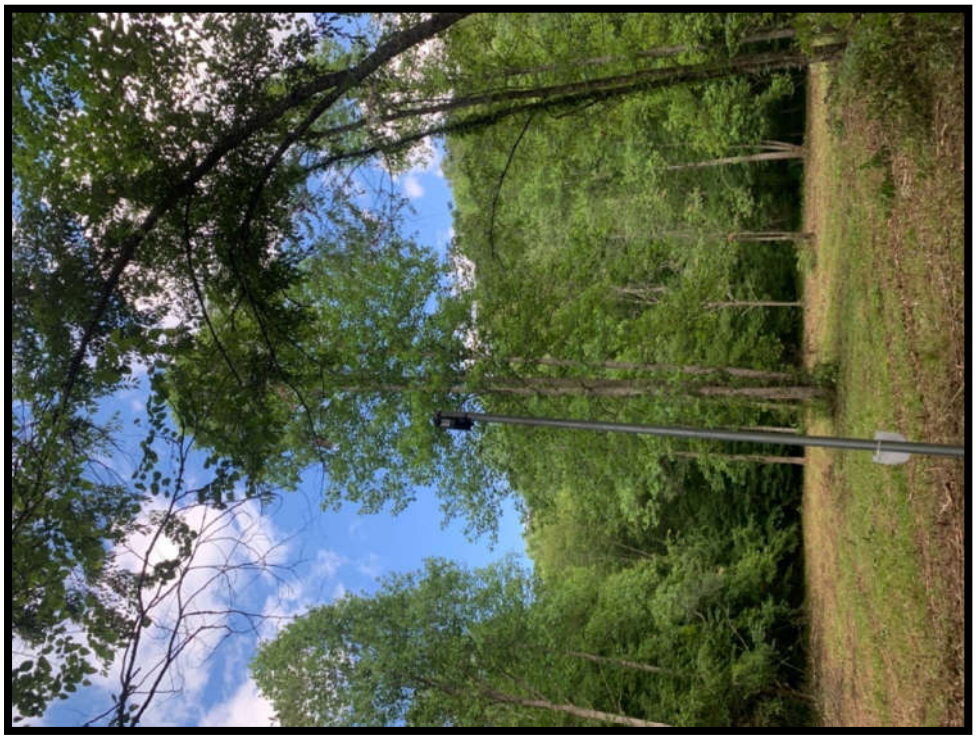
1562-AS-031 Area of Detection (1 of 4)



1562-AS-031 Acoustic Detector

1562-AS-031 Area of Detection (3 of 4)

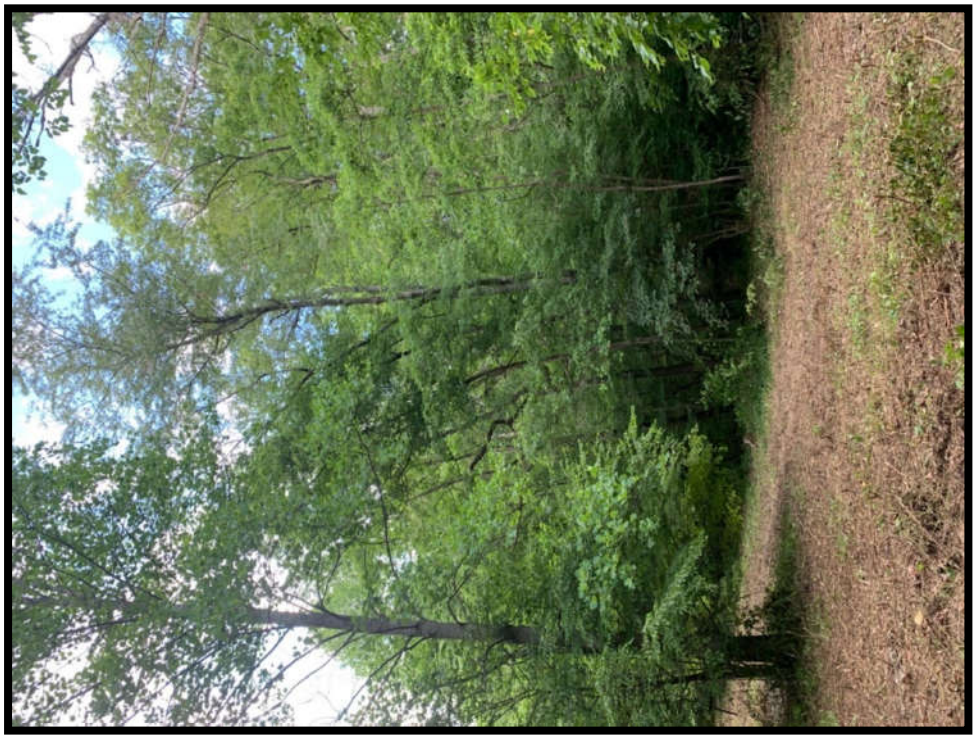
1562-AS-031 Area of Detection (2 of 4)



1562-AS-032 Acoustic Detector

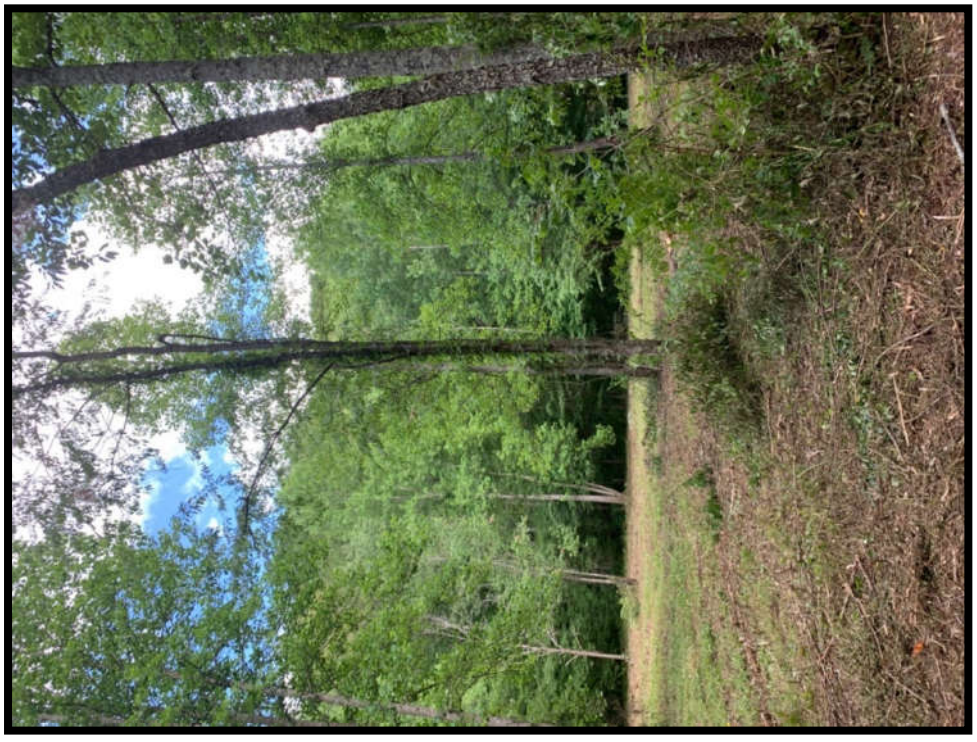
1562-AS-031 Area of Detection (4 of 4)

1562-AS-032 Area of Detection (2 of 4)



1562-AS-032 Area of Detection (1 of 4)

1562-AS-032 Area of Detection (4 of 4)



1562-AS-032 Area of Detection (3 of 4)

APPENDIX D
PATRICK MOORE RÉSUMÉ

Environmental Solutions & Innovations, Inc.
Real Science, Real Solutions

Patrick R. Moore
Senior Scientist
3851 S. Jefferson Avenue
Springfield, MO 65807
513-451-1777

EDUCATION

M.S., Biology - Master of Science, Biology Arkansas State University, 2016

B.S., Biology, Wildlife Ecology and Management. Arkansas State University, 2010

CERTIFICATIONS

Certified Wildlife Biologist, 2018-Current

Certified Ecologist, 2019-Current

Section 10 Permit T&E Bats, 2014-Current

QUALIFICATIONS AND EXPERIENCE

Mr. Moore is a Certified Wildlife Biologist® specializing in large, complex projects. For twelve years, he worked throughout Appalachia, the Ozark/Boston Mountain region, and the intermountain west, preforming all aspects of summer and winter bat surveys, migratory studies, and wildlife habitat surveys. Mr. Moore worked for numerous entities, both public and private, including the Ozark-St. Francis National Forest; Sumter National Forest; National Park Service; Arkansas Game and Fish Commission; Arkansas, Oklahoma, and Florida Departments of Transportation; and US Fish and Wildlife Refuges.

Mr. Moore is a recognized bat echolocation acoustic specialist. Following three years of experience, Mr. Moore attended a required six-day BatSense acoustic training course with Titley Scientific in 2014. In total, Mr. Moore conducted acoustic vetting and data management for nearly ten years. He is not only an expert in eastern bat call identification, but has extensive experience with western bats, neotropical bats, and niche species such as the Florida bonneted bat. Mr. Moore managed and vetted calls on acoustic projects from the east coast through the intermountain west, including experience on large-scale federal, national guard, and wind projects in Alabama, Arkansas, Illinois, Indiana, Missouri, Nevada, Montana, Oklahoma, Tennessee, Texas, West Virginia, Utah, and Virginia. Mr. Moore is approved to vet calls in high-threshold experience states such as Oklahoma. Mr. Moore conducts classes on acoustic analysis and assists in beta-testing new releases of Kaleidoscope Pro, and acoustic equipment from two companies. Mr. Moore is also one of the few qualified individuals with experience eliminating false-positive calls from southeastern myotis, often producing calls similar to federally-listed species.

PROJECT EXPERIENCE

Arkansas State University

Arkansas — *Principal Investigator*

Indiana bats/bat population surveys in Ozark-St. Francis National Forest in Arkansas. Responsible for mist netting and acoustic surveys, radio-telemetry and aerial tracking of Indiana bats, banding migratory and cave bat species found in Arkansas. Also conducted spatial modeling, made recommendations on habitat and timber stand improvements, and performed agency coordination.

Technical Lead
Arkansas State University — *Co-Principal Investigator*

Aerial foraging studies of 130 foraging gray bats in Arkansas. Developed methods and executed analysis of home range, core-foraging areas, and habitat-use. Study resulted in the publication "Habitat Use of Female Gray Bats Assessed using Aerial Telemetry" in the Journal of Wildlife Management.

Arkansas Game and Fish Commission
Arkansas — *Co-Principal Investigator*

Winter hibernacula and summer maternity counts throughout the state of Arkansas. Project includes monitoring 60-160 caves per year for population counts of all known caves harboring threatened and endangered bats. Population monitoring/WNS surveys conducted on other lower use caves. Conducted acoustic monitoring at hundreds of WMA sites.

Arkansas and Oklahoma Departments of Transportation
Arkansas and Oklahoma — *Technical Lead*

Bat acoustic surveys throughout Arkansas and eastern Oklahoma, including post-processing call vetting on bridges, roads, and culverts.

Various State and Private Clients
Florida — *Technical Lead*

Acoustic analysis on various projects for the Florida bonneted bat in Collier, Charlotte, Lee, and Osceola counties.

West Virginia Department of Highways
West Virginia — *Principal Investigator*

Acoustic and foraging study on Virginia big-eared bats (*Corynorhinus townsendii virginianus*) in northeastern West Virginia.

Private Client
Virginia and West Virginia — *Co-Principal Investigator*

Conducting a three-year continuous monitoring study of landscape effects to bats using 22 acoustic detectors across the Ridge and Valley region, both inside karst features and on the landscape.

Private Clients
Southeast, Midwest, and Intermountain West — *Co-Principal Investigator*

Seasonal and year-long acoustic projects, monitoring bat activity for pre-construction monitoring phases of facility development.

Camp Atterbury
Indiana — *Co-Principal Investigator*

Presence/absence acoustic monitoring for the endangered Indiana bat and threatened northern long-eared bat on a base-wide survey.

Duke Energy
North and South Carolina — *Principal Investigator*

NABat acoustic monitoring for species-presence composition over time. Includes yearly acoustic monitoring stations over a 40-year period.

APPENDIX E
WEATHER CONDITIONS

Appendix E. Hourly weather conditions during acoustic detector surveys on Houston South Study on Hoosier National Forest in Jackson, Lawrence, and Monroe counties, Indiana.

Date	Time	Temperature (°Fahrenheit)	Dew Point (°Fahrenheit)	Humidity (%)	Wind (Compass Heading)	Wind Speed (Miles per Hour)	Wind Gust (Miles per Hour)	Pressure (inches)	Precipitation (inches)	Conditions
10-Jul	19:54	83	64	53	W	17	25	29.03	0	Fair
	20:54	80	64	58	WNW	13	0	29.03	0	Fair
	21:54	77	64	64	W	9	0	29.03	0	Fair
	22:54	76	65	69	W	9	0	29.05	0	Fair
	23:54	74	64	71	WNW	10	0	29.05	0	Fair
	0:54	73	64	73	WNW	9	0	29.05	0	Partly Cloudy
	1:54	73	64	73	NW	8	0	29.05	0	Partly Cloudy
	2:54	71	64	78	NW	7	0	29.06	0	Partly Cloudy
	3:54	69	64	84	NW	7	0	29.06	0	Fair
	4:54	68	63	84	WNW	5	0	29.06	0	Fair
	5:54	67	63	87	W	5	0	29.06	0	Fair
	6:54	67	63	87	W	5	0	29.06	0	Fair
11-Jul	19:54	68	64	87	SW	5	0	29.02	0	Cloudy
	20:54	69	64	84	SSW	10	0	29.03	0	Cloudy
	21:54	69	65	87	WSW	3	0	29.02	0	Cloudy
	22:54	68	65	90	S	5	0	29.01	0	Cloudy
	23:54	68	65	90	S	5	0	29	0	Mostly Cloudy
	0:54	67	64	90	S	8	0	28.99	0	Mostly Cloudy
	1:09	67	65	93	W	22	26	29.05	0	Thunder / Windy
	1:27	65	63	93	W	23	44	29.04	0	T-Storm / Windy
	1:54	65	63	93	WNW	10	0	29.04	0.2	Light Rain with Thunder
	2:54	65	64	97	NE	8	0	28.98	0.3	T-Storm
	3:25	66	64	93	NE	12	28	28.94	0.1	T-Storm
	3:54	66	64	93	CALM	0	0	28.94	0.1	Light Rain with Thunder
	4:05	66	63	90	SW	6	0	28.94	0	Cloudy
	4:54	64	63	96	W	10	0	28.96	0	Partly Cloudy
	5:06	64	63	96	W	12	0	28.96	0	Mostly Cloudy
	5:47	64	63	96	W	9	0	28.99	0	Partly Cloudy
	19:54	81	64	56	N	10	0	29	0	Mostly Cloudy
	20:54	77	64	64	NNW	15	0	29.01	0	Mostly Cloudy

Date	Time	Temperature (°Fahrenheit)	Dew Point (°Fahrenheit)	Humidity (%)	Wind (Compass Heading)	Wind Speed (Miles per Hour)	Wind Gust (Miles per Hour)	Pressure (inches)	Precipitation (inches)	Conditions
	21:54	76	64	67	N	10	18	29.03	0	Partly Cloudy
	22:54	73	62	68	N	13	0	29.05	0	Partly Cloudy
	23:54	71	59	66	N	10	0	29.06	0	Fair
	0:54	67	64	90	S	8	0	28.99	0	Mostly Cloudy
	1:09	67	65	93	W	22	26	29.05	0	Thunder / Windy
	1:27	65	63	93	W	23	44	29.04	0	T-Storm / Windy
	1:54	65	63	93	WNW	10	0	29.04	0.2	Light Rain with Thunder
12-Jul	2:54	65	64	97	NE	8	0	28.98	0.3	T-Storm
	3:25	66	64	93	NE	12	28	28.94	0.1	T-Storm
	3:54	66	64	93	CALM	0	0	28.94	0.1	Light Rain with Thunder
	4:05	66	63	90	SW	6	0	28.94	0	Cloudy
	4:54	64	63	96	W	10	0	28.96	0	Partly Cloudy
	5:06	64	63	96	W	12	0	28.96	0	Mostly Cloudy
	5:47	64	63	96	W	9	0	28.99	0	Partly Cloudy
	5:54	64	63	96	NW	7	0	28.99	0	Partly Cloudy
	6:09	64	63	96	W	8	0	29	0	Cloudy
	6:54	64	63	96	W	9	0	29.01	0	Cloudy
	19:54	82	63	52	NW	8	0	29.24	0	Fair
	20:54	78	63	60	NW	6	0	29.25	0	Fair
	21:54	76	64	67	WNW	5	0	29.25	0	Fair
	22:54	74	64	71	WNW	5	0	29.27	0	Fair
	23:54	73	64	73	NW	5	0	29.26	0	Partly Cloudy
24-Jul	2:54	71	64	78	CALM	0	0	29.26	0	Fair
	1:54	71	64	78	CALM	0	0	29.26	0	Fair
	2:54	70	65	84	NNE	3	0	29.25	0	Fair
	3:54	66	64	93	W	6	0	29.26	0	Fair
	4:54	66	64	93	WNW	5	0	29.26	0	Fair
	5:54	66	63	90	NW	5	0	29.26	0	Fair
	6:54	66	63	90	NNW	5	0	29.29	0	Fair
	19:54	84	67	56	W	13	0	29.22	0	Partly Cloudy
	20:54	79	67	66	W	8	0	29.22	0	Partly Cloudy
	21:54	78	66	66	WNW	6	0	29.24	0	Partly Cloudy

Date	Time	Temperature (°Fahrenheit)	Dew Point (°Fahrenheit)	Humidity (%)	Wind (Compass Heading)	Wind Speed (Miles per Hour)	Wind Gust (Miles per Hour)	Pressure (inches)	Precipitation (inches)	Conditions
25-Jul	22:54	77	66	69	NW	5	0	29.24	0	Fair
	23:54	75	65	71	W	3	0	29.25	0	Partly Cloudy
	0:54	74	67	79	CALM	0	0	29.25	0	Fair
	1:54	72	66	81	SW	3	0	29.25	0	Fair
	2:54	70	67	90	WSW	3	0	29.25	0	Fair
	3:54	72	67	84	CALM	0	0	29.25	0	Fair
	4:54	70	66	87	CALM	0	0	29.24	0	Fair
	5:54	70	66	87	CALM	0	0	29.24	0	Fair
	6:54	71	67	87	SW	3	0	29.26	0	Fai
26-Jul	19:54	87	72	61	SW	12	0	29.14	0	Partly Cloudy
	20:54	84	73	69	SW	9	0	29.15	0	Partly Cloudy
	21:54	81	73	77	SW	6	0	29.16	0	Fair
	22:54	80	73	79	SSW	6	0	29.15	0	Fair
	23:54	79	74	84	SW	10	0	29.16	0	Partly Cloud
	0:54	78	74	87	SW	10	0	29.16	0	Fair
	1:54	78	74	87	WSW	13	0	29.16	0	Fair
	2:54	77	73	88	SW	12	0	29.15	0	Fair
	3:54	76	73	91	WSW	13	0	29.15	0	Fair
	4:54	75	73	94	SW	9	0	29.14	0	Fair
	5:54	75	72	90	SSW	9	0	29.12	0	Fair
	6:54	75	73	94	SSW	7	0	29.13	0	Fair

Source: https://www.wunderground.com/history/daily/us/in/indianapolis/KIND/date/2020-7-27